AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

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Multiple Spindle Valve Finishing Machine.

The illustration on this page is of a machine designed primarily for boring, facing and tapping brass valves, but is, of course, capable of doing many other kinds of work in the same class.

The machine consists essentially of a central column through the center of which passes a vertical shaft driven at the bottom by a pair of planed bevel gears and driving at the top, by means of spur gears, two sets of spindles; one for boring and facing, the other for tapping. Below the spindle is a rotating table to which are fixed the work-holding devices.

There are three boring and facing spindles which are placed equidistant about the central column and are all driven by the same gear on the central driving shaft. They are fed downwards by the usual rack, pinion and lever; a stop collar being provided at top which gauges the depth of the boring or facing. Counterbalances return these spindles to their highest positions, when the levers are released.

There are two tapping spindles, driven from the same central shaft at one-fourth the speed of the others, and these have a reversing motion inclosed in the casing seen just below the lower spindle bearings. This reversing motion consists of the usual double-ended clutch, spur gears being used to transmit the reverse motion. The arrangement is such that when these spindles are raised up to clear the work and are consequently running idly, the taps run in the reverse direction, but when brought down to the work their direction of rotation is automatically changed and the tapping begins, continuing to the desired depth as limited by the stop collar when the tap is again automatically reversed and backed out.

There are six chucks for holding work—one more than the number of spindles—the extra chuck being the one from which the finished piece is removed and a rough casting inserted in its place, while the various operations are going on in the other chucks, the rotating table being indexed for six positions. The index lock-bolt for table is released by foot-treadle, a helical spring forcing it to place.

The chucks also revolve to bring the various faces of the work into position to be operated upon, and are indexed, the index pins being operated by the weighted levers seen beneath the table and released by the knee of the operator; one of the hand-wheels shown opposite each chuck being for rotating it, while the other is for closing the chuck upon the work.

Universal chucks upon the spindles accurately center and hold the tools, which are also driven by flats formed upon the upper ends of the tools which fit into milled slots.

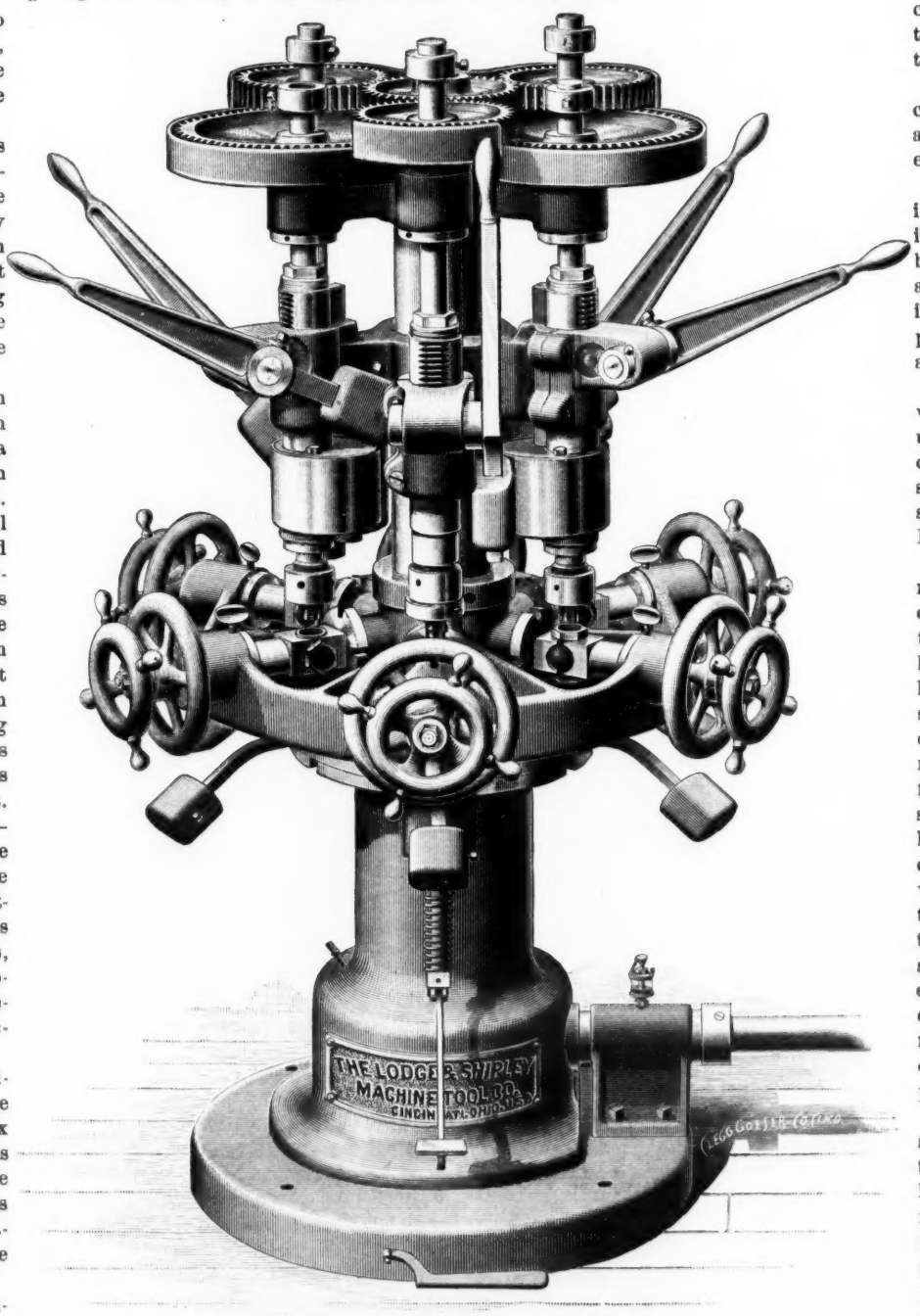
On the horizontal shaft below is a three-step cone pulley for a 4-inch belt, and the bevel gears for driving the upright shaft are of steel, cut by Bilgram.

The machine is furnished with everything needed for its operation, including a set of jaws for 1-inch valves. Other jaws may be readily made by the user, or are furnished to order by the makers of the machine, The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Philadelphia Shop Notes—II.

GEORGE V. CRESSON CO.

Though one of the older concerns of the city, the works of the George V. Cresson Co. are now practically new, recently erected new buildings, in addition to those built a few years ago when the company moved out of the crowded section of the city to Germantown Junction (corner Eighteenth street and Allegheny avenue, Philadelphia) giving them not only a very large, but also one of the most modern manufacturing plants. This company makes a specialty of transmission—makes miles of shafting, and tons of hangers, couplings, pulleys, etc., many of their methods of manufacture being quite unique.



MULTIPLE SPINDLE VALVE FINISHING MACHINE.

On page 2 is a cross-section of the buildings as now arranged, which will give a fair idea of the plant, and especially of the power transmission, which has some unusual features.

At the extreme left of the engraving is foundry No. 3, in which castings of brass, phosphor bronze and steel are made. This building is nearest the main line of the Philadelphia & Reading R. R., and is 34x65 feet. Adjoining it is foundry No. 2, which is for light work in iron, and is 100x65 feet.

In front of this, and at the left of the engine room, is a foundry storage house, with capacity for 100 tons of molding sand, 200 tons of coke, 300 tons of coal, and 1,500 tons of pig iron.

The engine room is 36x28 feet, back of this being the boiler room, 36x30 feet, and the cupola house, 34x25 feet.

At the right of the engine room is foundry No. 1, which is for heavy work, and is 200x55 feet, back of this being the carpenter shop, pattern shop, and pattern storage house, which are, altogether, 100x55 feet.

In the open space at the right of this is a track upon which a locomotive and car are seen standing, there being in this space, behind the general manager's office, a swinging jib crane.

In the building which carries the flag is the general manager's office, drawing room, shipping department, and store room, 108x21 feet.

At the right of the office building is machine shop No. 1, which is the older of the two machine shops. It is 500x50 feet, with a basement under it 250x50 feet, and is devoted to finishing pulleys, couplings, hangers, etc., and contains some special machines, though most of them are standard tools; Niles pulley lathes being used for turning pulleys.

A covered passage extends from this machine shop to machine shop No. 2, which is a very recently completed building at the extreme right, 244x108 feet.

Many new tools have been put in here, including, among the largest, a Pond 60-inch by 40-foot lathe, a Niles 16-20 foot boring-mill, and the largest size of Richards side planer (made by Pedrick & Ayer), in front of this tool being a deep, walled-up pit, which will take in the largest work they are likely to be called upon to handle.

In this shop they turn their shafting, which is made mainly of mild steel. They use no lathes in turning it, except for special pieces and the largest sizes, all other shafting being mad by a plant of special shafting machinery made by the Brightman Machine Company, of Cleveland, Ohio.

In this system of making shafting the rough bars, after being roughly straightened, are passed through a machine having feed rolls that feed the shaft through a hollow spindle having at each end a cutter head provided with four adjustable cutters, somewhat resembling lathe tools. The first of these through which the stock passes roughs it nearly to size, and the second finishes it—if it can be called a finish, the surface being, in fact, pretty rough as it leaves this machine. Abundance of lubricant is pumped onto the cutters, and the work goes on (absolutely without interruption, except for replacing dull cutters), at the rate of 1 foot in 80 seconds for 2-inch shafting, as timed by myself, which is equivalent to just 45 feet per hour. As the end of one shaft passes through the feed rolls, another follows and pushes the first one on through, after the manner of boards passing through a planing-mill.

From this machine the shafts go to a straightener, which is similar in construction to the ordinary wire straightener, but has very heavy hardened steel rolls that not only straighten the shaft approximately, but also planish the surface, putting a very good finish upon it. A man then finishes the straightening operation by the good old chalking method, the shaft revolving upon power driven rollers, and the force for doing the straightening being supplied by a special power driven press, the vertical plunger of which is driven by an eccentric.

It will be noticed that there is a plentiful supply of traveling cranes in these shops, and, in fact, the evident intention has been to have every modern improvement.

The power and transmission plant is somewhat unique, and the arrangement

will be readily understood from the engraving. It commences with a 350 horse-power Greene engine, running under; cotton ropes 1¼" and 1¾" diameter being used for transmission. There are at present nine of these ropes on the main wheel, and they are led off in three groups, as shown, with three ropes in each group, one of these groups of three passing through a long underground tunnel to the center of machine shop No. 1, where the ropes pass up to the line shaft, other ropes then passing from this shaft down to the tunnel and on to machine shop No. 2. The tunnel through which the ropes pass is large enough to be walked through readily, and is clean, dry and well lighted, communicating at intervals with the various basements which are used mainly for storing a very large stock of pulleys, hangers, etc. They report that the system gives excellent satisfaction. The ropes run at a speed of 4,000 feet per minute.

In the foundry I noticed a core oven, the inside of which was cylindrical and having at the center a vertical shaft, upon which were circular shelves for the cores to rest upon, these shelves being loosely held upon the shaft, so that any one of them can easily be rotated about the shaft to bring any desired core opposite the door. The shelves about fill the interior of the oven, and can be adjusted to any desired distance from each other, as they are supported by set-screwed collars upon the shaft.

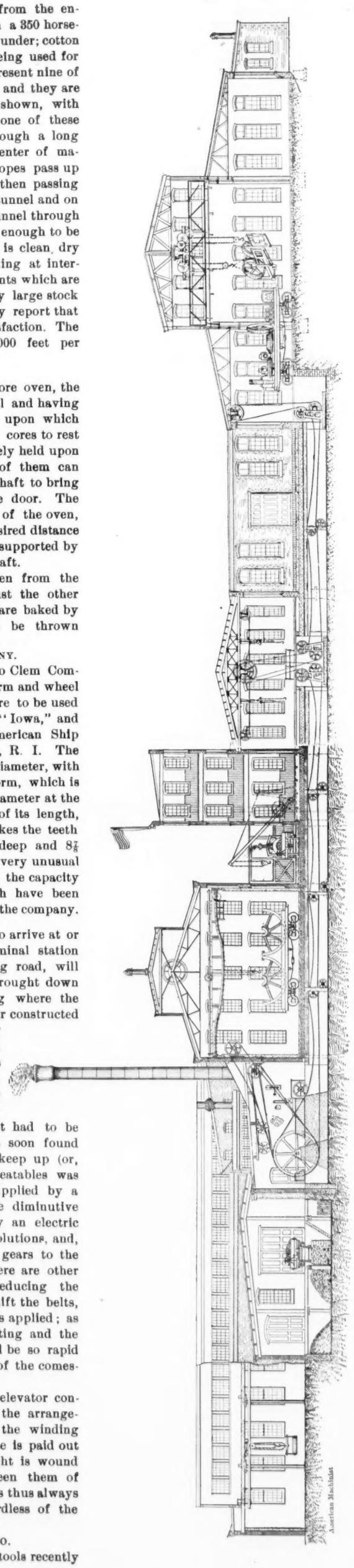
Heat for this oven is taken from the brass furnaces, which are just the other side of a wall, and thus cores are baked by heat which would otherwise be thrown away.

ALBRO CLEM COMPANY.

At the works of the Albro Clem Company they were making a worm and wheel that are remarkable. They are to be used in the new U. S. battleship "Iowa," and are being made for the American Ship Windlass Co., of Providence, R. I. The wheel will be 70 inches pitch diameter, with 50 teeth 4.398" pitch; the worm, which is of bronze, being 19½ inches diameter at the ends, 17 11/16 inches at the center of its length, and 34 inches long. This makes the teeth in the wheel about 3 inches deep and 8⅞ inches wide, which, though a very unusual job of hobbing, is well within the capacity of the special machines which have been constructed for such work by the company.

Visitors to Philadelphia who arrive at or depart from the fine new terminal station of the Philadelphia & Reading road, will have their soup, coffee, etc., brought down from the top of the building where the cooks are located, by an elevator constructed by the Albro Clem Company that has some unique features. The travel of the small car is through a distance of 104 feet, which it accomplishes in 20 seconds. At first the ordinary dumb waiter was put in that had to be worked by hand, but it was soon found that the energy required to keep up (or, rather down), the supply of eatables was much more than could be supplied by a man pulling upon ropes. The diminutive elevator put in is driven by an electric motor which runs at 1,950 revolutions, and, of course, there are reducing gears to the worm shaft, besides which there are other worm reducing gears for reducing the motion of those parts which shift the belts, and to which the band brake is applied; as otherwise, the motion of shifting and the retardation of the brake would be so rapid as to cause some disturbance of the comestibles.

These are new features in elevator construction, as is also, I believe, the arrangement of the wire ropes on the winding drum, by which as the car rope is paid out the rope for the counter-weight is wound on, there being space between them of about one groove. The drum is thus always nearly filled with rope, regardless of the position of the car.



BEMENT, MILES & CO.

One of the most noteworthy tools recently constructed by Bement, Miles & Co., is one which they call a double-head rotary planer, which is designed mainly for tooling the ends of long wrought girders, such as are used in structures of various kinds. Many of the machines used for this work plane but one end at a time, and are sometimes arranged to swivel to any desired angle.

The machine in question has a bed 70 feet long, and has a head fixed at one end, but arranged to swivel and feed at any desired angle. The other head also swivels to any desired angle, and is mounted upon a saddle, which is traversed upon the bed by power, clamps at any desired point, and is driven by an electric motor mounted upon the saddle. Each head has a cross-feed of 8 feet, and the movable head traverses upon the bed 50 feet, thus making it very convenient to simultaneously plane, at any angle, both ends of a beam of any length up to 55 feet, while, of course, the matter of length with method of driving adopted is simply a matter of length of bed and shop room to put it into. The machine as constructed weighs 75 tons, its great power and rigidity enabling extraordinarily heavy cuts to be taken. The Pencoyd Iron Works are to use it. For the Edison General Electric Company they are building a 14-20-foot boring-mill of unusually heavy proportions and power, the plan of which includes a large pit in which the main bearing is placed, and which is accessible by steps leading into it.

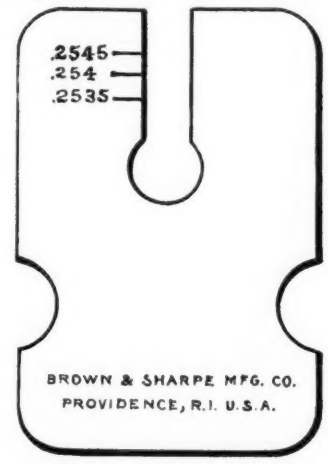
We have illustrated in these columns a small portable drilling machine, made by J. T. Halsey, at Twenty sixth and Callowhill streets. Since our illustration of it, Mr. Halsey has gone on developing the tool until in its present form a machine weighing 50 pounds, and driven by a rope belt, will drill 1 inch holes as rapidly as the best twist drills will stand, feeding automatically, releasing the feed at any predetermined point, and running it back rapidly by power. There is also a rapid traverse of the drill down to the work previous to throwing in the feed. All this is accomplished within the weight mentioned, and with scarcely any mechanism, simply because the feed is by means of a thread formed upon the spindle, and engaging with a nut which also revolves, but at a different speed. The spindle is then rapidly moved up or down by simply stopping the rotation of either the spindle or the nut, while the other continues its rotary motion. The machine as it operates is well calculated to surprise one who sees it for the first time, as it seems impossible that a machine so small, and with so little mechanism about it, should be capable of doing so much.

Some time ago we illustrated also a portable drilling, tapping and reaming machine which included its own power. We described this as a rotary engine, and outwardly it would be taken for such an engine. An examination of its internal arrangements, however, shows that it is not only not a rotary engine, but is more emphatically a reciprocating engine than most of those which go by that name; since there are four cylinders within the case, all of which contain reciprocating trunk pistons (the cylinders being single-acting), and two of the cylinders themselves reciprocate laterally a distance equal to the stroke. The cylinders are placed 90 degrees apart, and the four trunk pistons thus form a cross with arms of equal length, the crank-pin being at their intersection. The engine is capable of running at extremely high speed, and thus can develop considerable power within a very small space, and with small weight. The performance of the engine has indeed been so satisfactory for this purpose (requiring possibly ¼ to 1 horse-power) that an engine on the same plan is being constructed to develop 20 horse-power. In this the cylinders will be compounded and the governing will be by automatic variable cut-off, on all four cylinders. The engine will be so small as to make it almost possible for one man to lift it, and certainly two could do it easily, and thus we have a reciprocating, compound automatic engine of 20 horse-power that begins to approach in size and weight the 20 horse power steam turbine shown at Chicago. F. J. M.

Limit Gauge.

The Brown & Sharpe Manufacturing Company, of Providence, R. I., are now making for the market a form of limit gauge which they have found very useful in their own factory, and which is illustrated by the accompanying outline engraving.

The opening in the gauge is slightly tapering, and is standard size at the middle of its depth; at each side of this there are



Limit Gauge.

marks indicating points at which the opposing faces of the gauge are above or below the standard size, this limit in the gauge illustrated being as shown .0005 inch, or one half a thousandth. By this means the indication of a variation of .0005 inch becomes greatly magnified and work can be very rapidly and accurately gauged within the specified limits, and by estimation variations of one-half this limit may very readily be detected.

Forging by Hydraulic Pressure—The Institution of Civil Engineers (England).

At the meeting on Tuesday, the 20th of February, Mr. Alfred Giles, president, in the chair, the paper read was on "Forging by Hydraulic Pressure," by Mr. R. H. Tweddell, M. Inst. C. E.

The paper commenced by a brief history of the development of the hydraulic forging press since the year 1846, when the late Sir Charles Fox proposed the attachment of different tools for the working of hot or cold iron to the tables of the Bramah press. The author then formulated the following conditions as necessary to be fulfilled to insure success in hydraulic forging: First, the press must be so proportioned as to insure the utmost rigidity, any movement of the main columns, of course, interfering with the correctness of the work; secondly, the crane power must be not only ample, but so arranged that weights reaching to 100 tons could be manipulated by unskilled laborers; thirdly, the details of the construction of such parts as the valves and pumping arrangements must be as perfect as possible. These conditions were discussed seriatim, and the author indicated the means by which they were met in the various types of forging presses now made. Proceeding to particular makes of press the paper gave descriptions of all those at present manufactured in England. This part of the paper concluded with a reference to the 22-hundredweight steel ingot exhibited in the 1851 Exhibition by a Sheffield firm, the size of which was then considered quite exceptional; and by quoting Fairbairn's opinion of the value of the steam hammer in building up large masses of iron for the manufacture of large guns and marine engine shafts.

The second part of the paper was devoted to a comparison between the hydraulic forging press and the steam hammer. Starting with the axiom that noise and waste of energy were convertible terms,

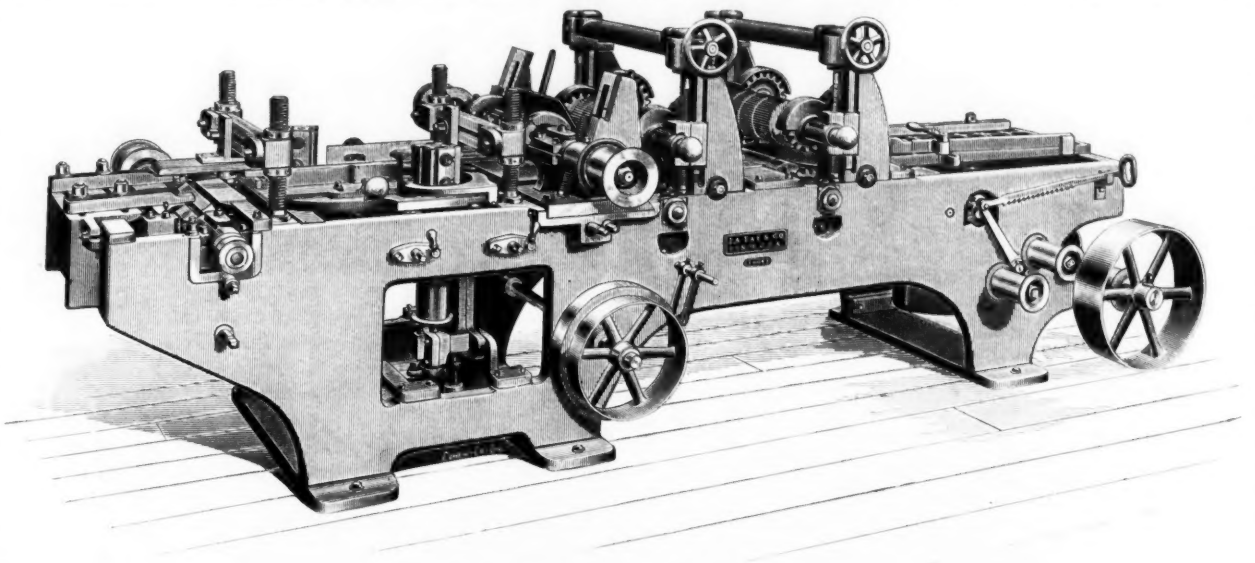
the author mentioned the points in which there could be no difference of opinion as to the superiority of the press. Its power was practically all exerted upon the forging and not dissipated in shocks to the framing and foundations; it also occupied much less head room than a hammer, and consequently traveling cranes could be used, passing, if necessary, over the press. Further, not only could more work be turned out by a press than by a steam hammer in a given time, but it could work through a much greater range, for while the effects of a "blow" shortened the life of any of the dies or tools used, it rendered impracticable the employment of numerous dies and molds which were satisfactory under pressure. The art of forging large masses had made distinct advances since the introduction of hydraulic pressure; for it was formerly impracticable to forge the hollow marine shafts at present used, or to draw out gun tubes or hoops on the mandril.

It was extremely difficult to draw the line where the tools described ceased to be forging presses and became stamping and welding machines. Here, there was more room for discussion as to the merits of forging press *versus* steam hammer, because many interesting questions arose as to the relative effect of a blow or a steady pressure when, for instance, stamping the iron work used in wheel making. The author had preferred to confine himself to the hydraulic forging press proper, and to eliminate the mechanical treatment of metals by forging or pressing as a whole. Much thought had been expended in trying to calculate the size of hydraulic press that would be equal to a steam hammer exerting a given force of blow, but in the opinion of the author the question was not worth pursuing, because until the amount of work done on the forging was equal and done in the same space of time no satisfactory comparison could be made. Owing to the action of the hydraulic press being constantly progressive, the tool continued to free its way into the ingot until its resistance to alteration of form was equal to the pressure on the ram, or the latter was removed. In this it differed entirely from the action of a hammer which, having delivered one blow, did no more work until the following one. This constituted the essential difference between the two machines. The effect of the hammer was momentary, and there was not time for the pressure it gave to penetrate the metal, much less to alter its form to any extent at one blow, but in the hydraulic press the same rate of working per hour could be maintained, while the material was allowed every opportunity to flow in the required direction without injury. The effect of hydraulic pressure on forgings was to increase their homogeneity. The blow of a steam hammer was given with least effect when it was most required, that was, it could not get its full stroke until the forging was reduced in size, whereas the press gave its full power at any point in its stroke.

The paper was accompanied by an appendix giving a detailed account of each of the forms of forging press alluded to in the text; by a note by Mr. Charles Davy, of Sheffield, comparing a press and a hammer doing nearly equivalent work; and by an account of some experiments by Mr. Coleman Sellers, of Philadelphia, on the number of hammer blows and the amount of hydraulic pressure required to deform similar test pieces to the same extent.

Improved Four-roll, Double-cylinder, Inside Molding Machine.

The accompanying illustration is of the latest type of heavy molding machines, which have been introduced to meet the demand for a molding machine that may be used for working all styles of moldings, flooring, ceiling, siding, casing, etc., in a rapid and accurate manner. It will work material from ⅝" to 6" in thickness, and up to 13" in width, dressing all four sides at one operation. The frame is made with plate sides all joints planed and accurately fitted, holes bored and tapped to templates.



DOUBLE CYLINDER INSIDE MOLDING MACHINE.

The feed consists of four large fluted feed rolls, 7" in diameter, powerfully geared by a double-expansion gearing, and weighted and placed in the machine before the cut. They are arranged in sections as regularly sent out, but can be made solid, fluted or smooth, as desired. The shafts can be drawn out for the purpose of changing from fluted to smooth rolls or *vice versa*, and can be instantly lifted from the work for the purpose of withdrawing it, or stopping the feed, the mechanism not being shown in the cut. The machine is furnished regularly with two rates of feed—30 feet and 53 feet per minute. A binder operated from the feeding end controls the feed.

The cylinders, with their journals, are made of solid forged steel, slotted on their four faces, and provided with chip-breaking lips for cross grained lumber. The upper cylinder has journals 2¼" inches in diameter, and is arranged with two pulleys fitted with taper bearing and secured by a nut. It has an endwise movement for securing accurate adjustment of the cutters to the work without disturbing them after being set. The lower cylinder has journals 2¼" in diameter, and is arranged to belt with one pulley. It has an endwise movement for convenience in adjustment and a vertical movement for regulating the depth of cut.

The cylinder bearings are very heavy, long, and lined with the best lining material. Those of the upper cylinder are cast together, and planed to fit upright stands cast solid to a bed plate extending across the machine. The lower head is supported in an independent frame. An automatic pressure bar is placed before the cut, arranged so that its edge can be brought close to the cutters The bar after the cut of the upper cylinder and the bar before the cut of the lower cylinder have sectional clamping feet for holding down the work.

The side cutting spindles are 1 1/16" in diameter where the heads are applied, and are usually furnished with solid forged cutter heads, slotted on four faces. They are hung in heavy independent frames, so arranged that one cut comes in advance of the other. They are adjustable across the bed and have also a vertical and angular adjustment. The left-hand head is fitted with an improved weighted matcher clip, producing a uniform pressure on the material under all conditions. The side guides for the right-hand side cutter head are equipped with movable throat pieces.

Four 13½" knives on each upper and lower cylinder, two 6" knives on each side cutter head and one set of wrenches are furnished with the machine, and shimer matcher-heads can be also furnished.

The machine is made by J. A. Fay & Co., Cincinnati, O.

Post, Jib Crane.

We illustrate by the accompanying engraving a jib crane, which was designed originally to be attached to a column composed of rolled steel beams, the column having been put in, not with the idea of attaching a crane to it, but simply to support the runway of a traveling crane and the building. The crane is arranged to swing completely around it, passing under the traveling crane on one side and under a gallery floor on the other.

It has been customary in putting in such cranes to arrange them to swivel on pintles attached to one side of the column, which, of course, limits their use to the floor space on that side; while with present arrangement the entire floor space about the column is covered and work may be readily transferred to or from the traveling crane, and the floor underneath the gallery.

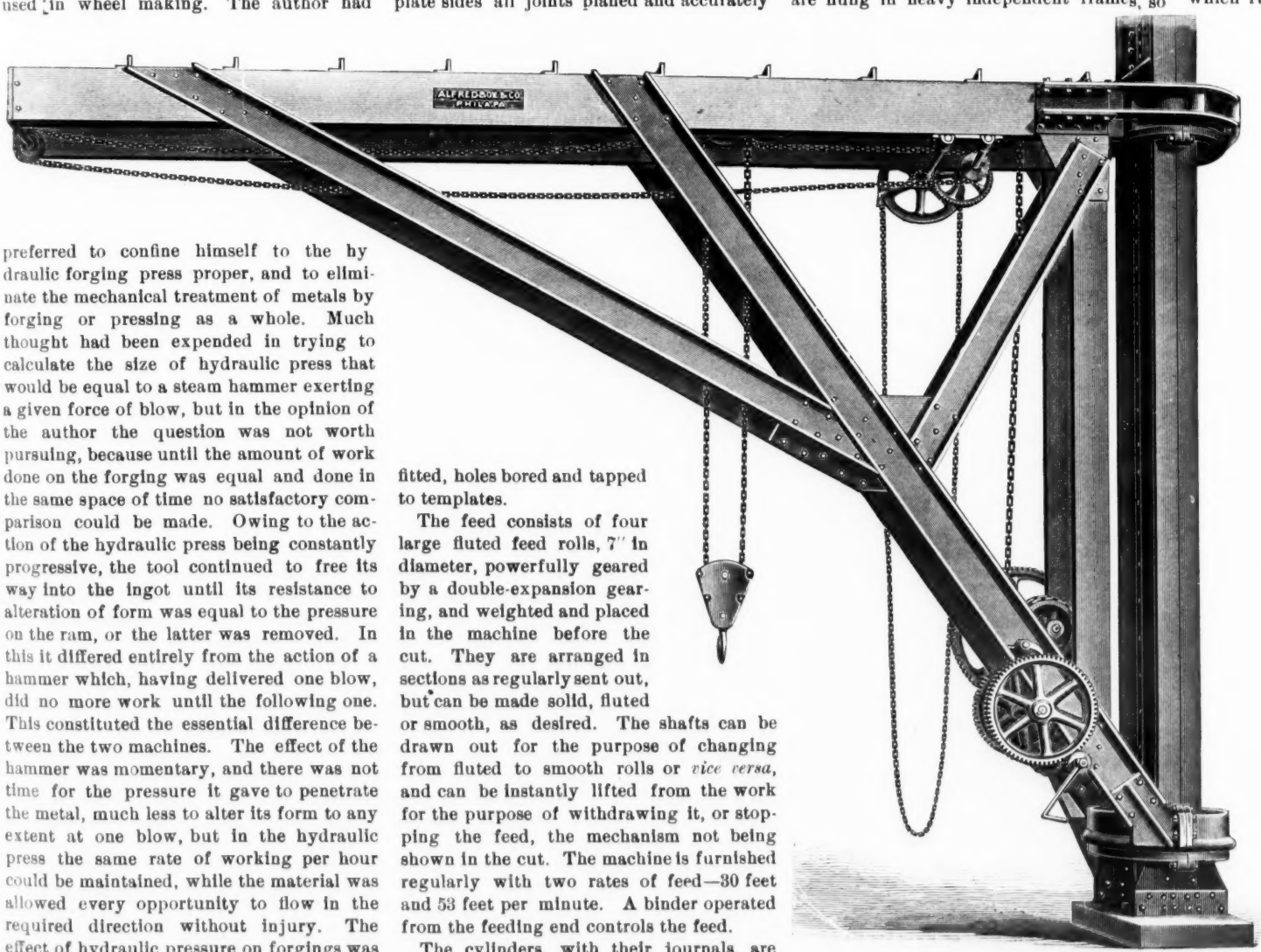
The arrangement for providing the crane with pintles consists simply of split rings which are formed to fit the column and bolted together upon it. Outwardly these are circular, of course, and form tracks upon which run rollers that are placed between these rings, and others which form parts of the crane, as shown.

With these bearings, though they are necessarily much larger in diameter than those usually employed for such a purpose, the crane swings with a very light pressure and is very easily handled.

Such cranes are made of almost any desired proportions and load, or for almost any form of column, the one shown being of 18 foot radius to lift 10 tons and applied to a column 30 inches by 20 inches.

Two men can handle the maximum load; roller bushings being provided all over to lessen friction.

The trolley runs between the two sides of the jib upon rails composed of the special shape suggested and used by Prof. Jno. E. Sweet, as described in our issue of February 12, 1891, and which, as will be remembered, serve to tie the two sides together through the medium of the trolley, in addition to which cross ties are put on overhead. This crane is made by Alfred Box & Co., Philadelphia, Pa.



POST, JIB CRANE.

"When I was a cub," remarked the old time machinist the other day, "when we wanted studs for a steam chest or cylinder head we used to make them. The holes were tapped out with a tap that crowded a little in the working, then the final fitting of the studs was done with the chaser. The studs used to stay where they were put," he continued. "Now," said he, "we use a tap that never taps the exact lead through excessive clearance, and we buy studs that are still more off lead. The result is that the first time we remove and replace a steam chest cover or cylinder head the thread on some of the studs is stripped, and we have to use anywhere from one to a half dozen 'bull head' studs." Of course, we believe there is a good deal of over-drawing in the old machinist's remarks, but at the same time there is something of truth in them as a good many can testify to.

A New Power Hammer.

The accompanying illustration represents a belt driven hammer, which is considered to possess some special advantages, particularly in respect of simplicity of construction.

The arrangement of driving pulley, shaft, adjustable crank-pin, etc., is clearly indicated. The connection between crank-pin and hammer head is through the medium of a cylindrical rod to which is clamped, in the manner shown, a spring fork, carrying at its lower extremities two rollers that are pressed outwardly against the curved surfaces shown. As these rollers are forced either downwards or upwards, from the position shown in the engraving, they are, by the converging form of the surfaces, pressed closer together against the resistance of the springs; and, in operation, there is, of course, always more or less of this motion, and thus the necessary elasticity of blow is secured by very simple means, and avoiding the use of some features which have proved objectionable or unreliable in practice.

The anvil block passes through the frame and rests upon an independent foundation. All needed adjustments and facilities for control of the hammer have been provided, and in practice it has proven highly efficient. It is made by Beaudry & Co., 48 Congress street, Boston, Mass.

A New Power Hammer.

Motor-driven Engine Lathe.

In our issue of March 1st we illustrated an engine lathe built originally to be driven by belt, but arranged subsequently for driving by an electric motor.

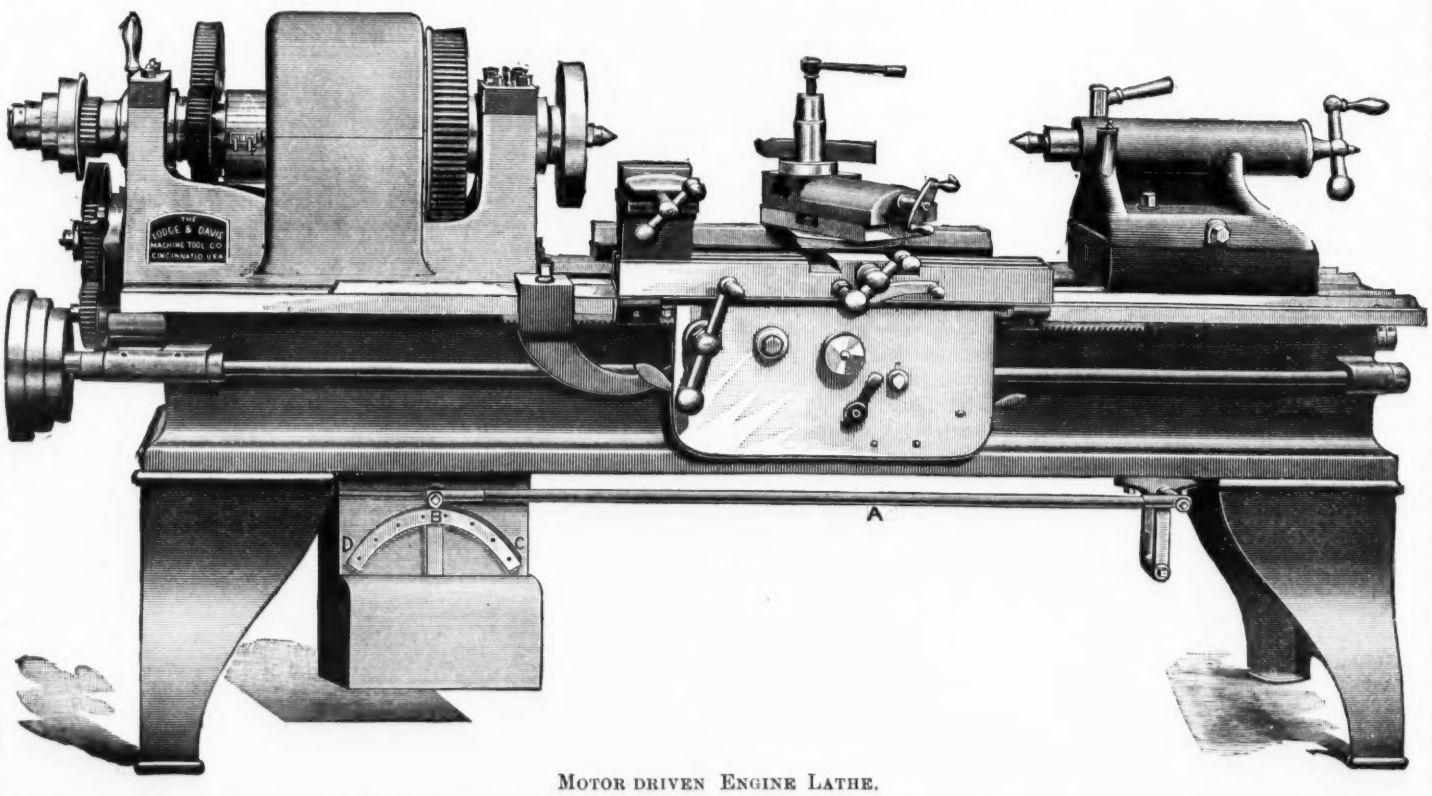
We present herewith a lathe in which the design includes an electric motor, which takes the place of the usual cone pulley.

As in the former case the lathe is reversed and the speed regulated by the movement of the rod *A*, this with the back gears, arranged as usual, giving, not only a much wider range of speeds than can be obtained by cone pulley, but a much more finely graduated speed; in fact, the speed may be anything from the highest to the lowest desired.

The armature is wound on a phosphor bronze spider with a carrier disk which revolves freely on spindle same as cone pulley. It is surrounded by pole-pieces inclosed in housing, lower half of which is cast in one piece with head-stock proper, to which the upper half is substantially fitted and secured by means of four bolts. This construction forms what is known as an "iron-clad motor" entirely free from external magnetism. This is necessary in order to prevent small particles of iron and steel adhering to lathe, making it impossible to keep it clean.

Amongst the advantages secured by such an application of electricity are that tools may be placed independently of overhead fixtures, such as shafting, cranes, etc., and with regard to the arrangement best suited to handle the product most conveniently; a saving of power is effected; and, the operator has better control of his machine, especially when a variable speed is necessary, owing, of course, to the nice adjustment possible. This lathe was built by the Lodge & Davis Machine Tool Co., of Cincinnati, who are giving special attention to equipping the various classes of machine tools they build with electric motors.

The motors, which are furnished by the Card Electric Motor and Dynamo Co., of the same place, are simple, substantial, and of sufficient capacity for maximum load, entirely free from complication and requiring very little attention in use.



Motor driven Engine Lathe.

Those who pin their faith to the exports and imports of the country, should gather courage from the fact that during the past eight months the excess of exports over imports for this country have been between $200,000,000 and $300,000,000. We are not arguing that this is a sign of prosperity, but give it for the benefit of those who believe in the "balance of trade." A corresponding period last year showed this excess to be less than $30,000,000.

The first contract for postal cards in this country was at the rate of $1.40 per thousand; the sixth and last at 33 cents. The large cards are proving much the most popular.

LETTERS FROM PRACTICAL MEN.

"Me Oldest Boy."

Editor American Machinist:

The very excellent off-hand sketch which Mr. Norris furnishes with his letter under the above title, in your issue of March 8th, is of a thing, which though apparently new to Mr. Norris, is really very common among the smiths in England, and now and then among those Englishmen who have come among us bringing "the tools of their trade," free of tariff exactions.

I have often thought when viewing these old traps, that there must be some very acute minds in our revenue department, that are able to draw the line so finely between "tools of trade" and "machines for iron working," the latter only being taxable.

The name of this striker is "Nolly," or "Olly," or "Holly," or "Dolly," according to the aspirations of the smith, and in the more refined language of the books is printed "an Oliver," why, I know not, unless there may be some fancied resemblance in its forceful action, to that of the Oliver who struck off the head of his king.

Mr. Norris' little sketch, showing the weight of the hammer held up by a spring pole, looks a little like one of the *Paradoxes mechanicales*, and it seems to me that it would be a good thing for the authorities of Cornell to add it to their museum, and then have the young men demonstrate mathematically whether or not it will strike at all.

One other thought which occurs to me, in view of the fact which Mr. Norris has revealed, the using of such a fresh water contrivance as a "wrought iron tiller," and which fetched away in mid-lake, is the need of a chair of naval construction for the university. William H. Harrison.

Braintree, Mass.

Concave Indentation—Blow-holes and Sulphur in Iron and Fuel.

Editor American Machinist:

Mr. W. H. Drake, by his inquiring, "What makes the holes in the castings," in your issue of January 18, 1894, has called forth some valuable and interesting replies, as they give causes and remedies for blow-holes which could be applied to very many cases, but in reading Mr. Drake's letter the assertion that he had made these same castings before and experienced no trouble, leads me to think there is a slight probability of his iron causing such holes. We all could, of course, reason much more intelligently had Mr. Drake illustrated with cuts the exact design of his casting, method of gating and all the details of molding.

In the American Machinist of March 1st, Mr. Drake refers to "Molder's Text-book," page 213, and thinks I therein concisely describe the character of his blow-holes, but after a careful reading of same and the description he gives of his blows, I am led to believe they differ in character, and in order to make myself clear to your readers, I will cite a part of the chapter Mr. Drake has called attention to. . .

. . . "In this country the sea coal used in our foundries is principally derived from the mining regions of the Youghiogheny and Cumberland districts, and is selected for its freedom from slate and sulphur and its gas bearing qualities. The quality of sea coal blacking is less variable than that of any other blacking made, simply from the fact of its not being mixed with any other substance. Sea coal, being mixed in with the sand, divides the particles or fusible elements of sand, and what it doesn't divide it emits its gas among. The hydrogen and carbon sea coal contains prevent, to a degree, sand fusing. There is a limit to the percentage of sea coal that should be mixed with sand. When more than one of sea coal to six of sand is used, unless the surface of the mold be well coated with good blacking or silver lead and the metal poured dull, there is in the heavy body of metal molds much danger of the surface of the casting being more or less streaked or veined. Thorough mixing of facing sand will to a large degree prevent this defect. When iron is poured into a mold faced with sand containing sea coal, there is much gas generated. This gas, if not driven off by pressure, forms more or less of a cushion between the surface of the mold and the metal. This cushion often prevents the iron from running into the corners and edges of molds, and also often causes cold shuts and *smooth concave indentations* in castings. Molds having been poured with dull iron, although the casting may be heavily proportioned, will often present some of the above defects. In faced molds

more or less of a gas cushion is raised, and according to the amount of pressure and the fluidity of the metal, the faster this cushion is destroyed. When strong facings are used upon thin castings or those poured dull, the metal often becomes set before this cushion is all destroyed." . . .

. . . Now, the description Mr. Drake gives of his castings' blow-holes is as follows: "These holes do not usually go all the way through the plates, but are from $\frac{1}{2}$" to 1" across and about $\frac{1}{4}$" deep, leaving $\frac{1}{4}$" of solid iron between the hole and the core with a very thin film of iron above the holes next the sand in cope."

This character of a blow-hole is not what I would infer to mean a "smooth concave indentation," as cited in the above extract. What I desire to be understood as a smooth concave indentation, is a smooth hollow in the surface of a casting, and which may exist in the cope or nowel surface of a casting. Mr. Drake's blow-holes are not, as I would understand it, of such a character as he describes there, "leaving about $\frac{1}{4}$" of solid iron between the hole and the core, *with a very thin film of iron* above the holes next the sand in the cope." Such are, practically speaking, *holes in the castings*, whereas "smooth concave indentations" are simply hollows on its surface; but both can result from improper liberation of gases, and as this is an interesting and valuable subject, I feel the reader will excuse me if I dwell a little on details in endeavoring to intelligently explain some causes I have attributed for inner and outer blow-holes or hollows; and to treat of the latter I will first cite an incident that many years back occurred with the writer while casting a number of "open sand" plates measuring about four feet square by one inch thick. There being but little shop room to be given up to the number of plates to be cast that day, I thought I would mold them as close together as possible and try all I could to oblige the foreman in getting out all his plates, as they were in a great hurry for them. The space I allowed between the plates was something like 2", and I molded them in a double row, which admitted of pouring from each side with a crane ladle. We first poured the plates on the outer ends of each bed, so as to admit of covering them over with sand so as their heat would not prevent a comfortable pouring of the middle plates. The outer plate poured beautifully, but the music commenced when we started in on the middle plates, and the more we poured the louder the band played, and, to our surprise, it had such an elevating effect that some of the plates raised up in their center portion as high as 4" clear up from their beds, while the metal was in a semi molten condition. The cause of this was, the vent of the latter poured plates drawing the confined gases, which were confined under the first or outer poured plates, in under them, and the beds having been made wholly without vents, there was not sufficient head pressure or thickness of metal to compress the gas or drive it outward, but finding the least resistance by "kicking" its way through the metal while fluid and when semi-solidified, creating space for itself by raising the center portion of the plates up off their beds, as described above. It is evident the bed was properly made for "open sand" work, from the fact of the outer or first-poured plates casting all right; and the center or latter poured plates would have "went off" all right also, had we only closely run a row of vertical $\frac{1}{4}$" or $\frac{3}{8}$" vents down into the narrow strips of sand dividing the plates. All the excuse I have to offer is, "I did not think," and waited until sad experience taught me a lesson.

The solution to the above is one which when understood cannot but lead us to clearly define the causes for "smooth concave indentations," as often created by the improper liberation of gases, from any cause, in the bottom or core portion of molds, and when "smooth concave indentations" are found on the "cope" side of a casting, one is generally sure they are caused by compressed gas or air, which became so through the ill-vented or too compact nature of the cope covering; preventing the expanded gases or air from escaping. The compactness can be caused by hard ramming, wet sand, or sand being of too close or loamy a nature.

In regard to the character of holes Mr. Drake describes, I would first look to the cope covering as the cause, and expect to find them rammed too hard, sand too wet, or of too close a nature, with not sufficient of the vent wire. Mr. Gilmour advises the use of common heap sand, rammed lightly, and roughly finished without blacking. This should be a cure for the character of holes Mr. Drake describes. The question of pressure or "flowing off," advanced by several correspondents, is a very good thing in many cases, but I do not think that would assist to any great degree in expelling the expanded gases or air, causing holes of the character cited. Make a mold right, and extra head pressure, simply for the purpose of driving out gases, is very seldom a necessity.

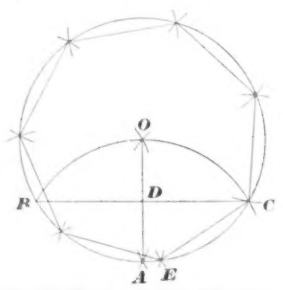
Mr. Drake's assertion of having made the casting before, and experiencing no difficulty, rather forces one to look to the cause which he ascribes, and while I will not dispute it, still I cannot bring myself to believe such to be the cause, for in my whole experience I never saw such blow holes as described being caused by elements in the iron, and I do not at all like the idea of giving an ear to such a doctrine, as it opens up such a grand opportunity for offering excuses to evade the responsibility for turning out good work; but, nevertheless, we must attach some weight to Mr. Drake's opinion, as he is the doctor, and has his patient daily before him, whereas we are attempting to prescribe very blindly a remedy for an ill with a good deal of the kill or cure principle about it.

Mr. Drake says his pig metal is full of holes and that the iron bubbles and boils when in the ladle. There are few molders that would expect to obtain a perfectly sound casting from metal bubbling and boiling when in the ladle. There is a strong probability of something being wrong with metal when it acts like that. If Mr. Drake had told us his castings were harder made from his objectionable pig than that working all right, we could feel more safe in saying his metal was too high in sulphur or low in silicon, and which if not melted very hot would solidify rapidly, and when poured into the mold the affinity of large bodies to attract small might be such as to cause the collection of gas in the holes he cites, and which from rapid chilling of the metal did not have time to escape; for it is asserted by blast furnace men that sulphur will raise and endeavor to escape as long as the metal in the pig beds remains fluid or hot, and where sulphur exists analysis will show the upper portion of "pigs" to be the highest in sulphur, as the top contains more sulphur than the bottom, thus going to prove that the sulphur was caught by the liquid metal solidifying before the sulphur had time to escape, and in pig metal high in sulphur and low in silicon, you will generally find the top or face of the pigs to be honeycombed and have a pock-marked or rough surface. Where sulphur is low you find silicon to be high, and *vice versa*. This is as it generally works, but there are cases where there will be high sulphur with high silicon, but such cases are very rare and due to some improper workings of the blast furnace. Iron high in sulphur or low in silicon should be melted hot as possible before one can commence to expect to get good castings, especially off from such a pattern as Mr. Drake describes; but I believe he has said his iron was melted hot, so we cannot look to dullness of his metal being the cause.

Pigs low in sulphur are told by their smooth face. Experienced blast furnace men can generally, by looking at a pig, tell very closely the percentage of sulphur and silicon it contains.

If Mr. Drake's pig metal shows a rough surface and has holes in it, I would be led to say it was not a desirable metal to expect to obtain good castings from, such as Mr. Drake is making, and if he should at the same time have fuel high in sulphur, of which there is a chance, for in foundry practice one evil seldom goes a begging for company, it is sure to aggravate his troubles. A chemist would come in very nicely to assist Mr. Drake, and I would advise him to have his objectionable iron and also his coke analyzed.

THOMAS D. WEST.



Construction of the Heptagon.

Editor American Machinist:

Here is another way to construct a heptagon. Draw a circle of required size. From *A*, using the same radius, draw the arc *B O C*. Connect points *B* and *C*. Bisect line *B C*. With *C D* as radius, draw arc *D E*. Connect *C* and *E* and you have one side of the heptagon.

The line *B C* is the same as one side of an inscribed equilateral triangle, so we may say that in the same or equal circles, one side of an inscribed heptagon is equal to $(\frac{1}{2})$ one half of one side of an inscribed equilateral triangle.

This method may not be according to Hoyle, but it is nearer than the draftsman will probably get the first time he tries it.

Madison, Wis. B. A.

Unsound Castings.

Editor American Machinist:

My experience in chilling castings is that every chill ought to be turned or planed. When this is not done the iron does not lie fairly against it. After turning or planing, as the case may be, the surface should be rusted over night and then rubbed off with a piece of emery cloth, then rust again, once or twice, and clean. Before using rub it with a piece of waste dampened with kerosene, then rub dry. Have the chill nice and dry and fill quickly with hot metal. Have as little gas as possible in the core.

M. D. WENDLING.

High-speed Engines—Belts—Spontaneous Combustion.

Editor American Machinist:

There have lately appeared in different publications articles which seem to show that in many minds there is a tendency to revolt against the carrying too far of high speeds. Mr. Porter, of high speed engine fame, has shown how engine speeds are, in his opinion, too high or tending to become so, and to such a pitch has the high velocity craze risen that I have found men discarding most convenient mechanical arrangements because they could not provide for the speed they had come to fancy was absolutely necessary. Ropes and belts have been, perhaps, more pushed to high velocities than anything else, and yet beyond 4,000 feet per minute their efficiency increases very slowly up to a maximum, and then falls off on account of the rapid rise of the centrifugal forces. Where higher speeds are inadmissible, lower ones of 1,200 to 2,000 feet have at least the advantage in small wear and tear, and in a very small loss from centrifugal stress. We are always liable to carry our ideas too far; we find a certain sequence holding good up to a point within our reach, and, as our range of practice is widened, assume unthinkingly that the sequence will continue. In steam-engine work the automatic cut-off has been worked for all it is worth, and has certainly done good duty in its time, but the Willans engine performances seem to show that the conditions of to-day as to speeds and pressures have put a limit to the value of regulation by cut-off and the small gain due to cut-off is made doubly small in the case of an electrical station of several units, all but one of which are run at their most economical rate of power, and the odd one is throttled until such time as change of load calls for the entire stoppage of one unit or the starting of another.

The question of long connections for indicators has been raised. If we take a fairly high speed engine, making five revolutions per second, with an indicator one foot from the cylinder end, we have the period of the engine half revolution equal to one-tenth second. Assuming the steam to flow at 100 feet per second, the length of one foot of pipe will be filled in the hundredth part of one second, during which time the crank has turned one tenth of its half revolution or 18 degrees of arc movement, the piston travel of which is nearly three tenths inch on a 12 inch stroke. The steam line of the indicator diagram would thus show somewhat inclined when it should be vertical, and the top corner might be a little rounded, whereas actually the facts would make it square, but this assumes, of course, that the pipe was nearly empty and had to be filled; the expansion curve would not show the same retardation and the diagram would not differ much where the pipes were of good size. The speed of 100 feet per second is a usual rate for steam pipe proportioning, and by no means indicates a maximum velocity, so, that if nicely put in and of ample size there does not appear any very serious cause for fearing the use of long indicator connections, and all who have much experience in engine testing with only one indicator, will agree that a single indicator tap for both ends of a cylinder is most convenient to use, saving the continual changing of the instrument. The danger of the arrangement is in the possible leakage past the stop taps, for which reason a single central two way cock should be avoided.

The "Notes on Belting," by F.W. Taylor, remind me of an experience of some years ago where we had constant trouble from the 4 inch belts driving certain machines, and at last we increased the width to 5 inches, and all trouble ceased. For large belts of double leather it is usual to allow 70 to 80 pounds of stress per inch of width in determining the horse-power. If to this we add for slack side tension and centrifugal force we arrive at a total pull in the belt of probably 130 pounds, or, say, nearly 350 pounds, as a maximum per square inch of cross-section. This stress would assume a copper-sewn and cemented belt of considerable breadth, say 18 to 36 inches. For narrower belts probably the stress would be too great.

At present I am using canvas belts, as I find they run perfectly true and have a much tidier appearance than leather, and so far they appear to justify their selection. When a belt is crossed or half-crossed, and especially when short, its stress per inch should be reduced. Recently a friend came to me with a question about a crossed belt that he wanted to transmit a considerable power, but the shaft centers were very close and the twist upon the wide belt would be very severe. I told him to have his new pulley turned with a double-barreled crown, and use two belts of half width, and he has done so with very satisfactory results, twisting one belt to the right and the other to the left for symmetry of appearance.

Mr. Payler asks concerning methods of preventing spontaneous ignition of coal in mass. The best method appears to be the burial in the mass of coal of a number of cylinders of liquid carbonic acid gas which are sealed by some easily fusible alloy. As the coal heats the alloy fuses and the liquid gas escapes, putting out any fire that may have started within range of the influence of the gas and replacing heated air and gas by an exceedingly cold non-fire supporting gas. This system is said to insure absolute safety, for coal, once heated and cooled, does not again ignite spontaneously. Any cylinder that has not gone off is reshipped in another cargo.

This gas compression has, however, brought with it a new danger. Recently a boy let fall a cylinder of compressed oxygen, which had a flaw in it, it exploded and killed the boy, and these accidents are liable to be frequent. No one seems to take much notice of these little gas cylinders,

and they are thrown about very recklessly. Both air and oxygen have recently been liquefied in considerable quantities, oxygen at a lower temperature than nitrogen, so that when air is liquefied the oxygen can be obtained pure by allowing the nitrogen to boil off. The possession of liquid oxygen seems to present the opportunity of securing low temperatures for purposes of scientific research hitherto impossible. Within 140 degrees of absolute 0°, or zero, has, I believe, been attained. Professor Dewar, who has been doing all this, now tells us that iron which at 15° C. will resist 30 tons, has its tensile strength doubled, if cooled to —180° C., all which is in the direction of probability. Concerning the bursting of the oxygen cylinder, some tests upon the exploded cylinder and upon other cylinders *known* to have been annealed have demonstrated the probability that the cylinder which exploded had not been annealed, a sound and annealed fully charged cylinder having been dropped as much as 50 feet upon an iron block without failure, and finally crushed in a hydraulic press until it finally did give way, but it merely tore open, and did not throw fragments around. It proved, in fact, the exceedingly reliable nature of mild steel *when properly annealed*, and the moral is that makers of these high-pressure gas cylinders should be urged to exercise careful supervision over the annealing of every cylinder by being responsible for the results of any burst which might arise from neglect of this precaution.

Reverting to the thought which commenced this letter, it is worth considering in regard to keeping the speeds of rope or belt connections to a moderate figure that quite apart from the useless stress which arises from the centrifugal action of a high-speed belt there is the rapid reduction of the adhesion. At 90 miles per hour the ordinary allowances of working stress in a rope are entirely swallowed up in centrifugal stress and a rope will perform no work external to itself without being stressed beyond the ordinary working allowance of about three hundred pounds per inch of section. Further, not only do we throw away some of the adhesion by employing such high speeds but we increase the number of bendings of the rope round its pulleys, and it is well known that wearing of a rope is more due to internal than to external friction as a rule. At least this is so when the material of the rope—its individual fibers—is rough and uneven like manilla. Still again, in a rope traveling at 100 feet per second as against one traveling at only 60 feet there is nearly double as much rope to be pulled out of the wedge grooves in one case as in the other. This is simply so much power lost.

Taking a rope in each case of a weight of one pound per linear foot, and a total stress allowance of 600 pounds, the net working side tension in each case will be 540 pounds, if we deduct 10 per cent. for slack side tension. The centrifugal stresses in the two cases are 109 pounds and 306 pounds, respectively, leaving a net stress available for work of 431 pounds and 234 pounds.

Multiplying each of these by the speed, we obtain for the 60-speed rope a product 25,860 foot-pounds and for the 100 speed rope 23,400 foot-pounds. The slower rope is thus the more powerful, the two velocities being about equally removed from the 80 feet per second, which gives a maximum result of 27,760 foot-pounds. Having found the speed of maximum effect, good design would always indicate something more moderate, so that the losses above pointed out may be below the maximum. In taking off 10 per cent. from the total allowable tension of a rope, we must remember that whether this figure be or be not a correct allowance for the slack side tension, any increase of velocity calls for an increase in this to make up for the increase of centrifugal stress. Everything points to the use of moderate speeds and to the use of a material for ropes or belts which has least weight per foot run for the allowed tension. I find there is a lack of correct information upon the question of weights of ropes. Mr. Flather, in the *Electrical World*, of New York, quotes a table of weights and strengths of cotton ropes, which, whether correct or not for a certain class of soft rope, is entirely wrong for hard close-spun driving ropes, the weights per foot, for example, being only six-tenths of what is the actual strength, and the breaking stresses being also several fold less than are usually figured upon, of which I hope to send more information.

W. H. Booth.

Economical Shop Management.

Editor American Machinist:

It is probably safe to say that nearly every shop manager in the country has his own ideas on this subject, and equally probable that very few would agree as to the economy of methods used by the others. Many of the little refinements which go to make up the comfort of shop life, and which are real economies in so far as they make work more pleasant and easy, would be looked upon as unnecessary by many stern economists. The circular which is reproduced in your issue of January 4th, by W. D. Forbes & Co. (Engineers), shows a step in the right direction; the economies mentioned there go farther than one would think in determining the real economical management of the shop, and furthermore, it tells which of the men to let go when this becomes a necessity. The amount of material needlessly wasted every year in many shops would make quite a respectable dividend if strictly accounted for, although in most instances this is the fault of the shop foreman or the superintendent in having such an amount of stock to be removed from castings and forgings. The blacksmith prefers giving a little too much allowance to not having enough stock on the piece, and this is a source of waste, for if proper care is taken the limit can be maintained very closely, while if sufficient quantities are made they should be drop-forged, if possible. This same treatment applies to castings, and it pays to pay pretty close attention to new patterns and see just how much allowance they need for shrinkage, and then if possible or prudent have a metal one made so as to avoid changes in the wooden pattern, with its annoyances, where allowances are close. It is often quite a problem to know how to light the shop to best advantage, what form of light to use, how to place it, how to economize in its use, etc. There can be little disputing that the cheapest, and, in most instances, best light is the light of day, which costs so little and which is too often shut out either for architectural effect or on account of dirty window panes. By all means have the shop light, windows are not expensive, and a shop which looks as though the sides were only made to hold the windows together, or to give room for them, is pretty sure to be well lighted, and it is difficult to get too much light for ordinary work.

The light from the top, through skylights in plenty, is in most instances the best light to work by, as the shadows are all below the work, and for lathe work this is not often objectionable. The writer knows of one shop room where the architects left four or five feet of blank wall above the windows, instead of letting the windows go all the way up, simply to obtain a good effect from the outside—a case of common sense sacrificed for appearance sake, to say nothing of the extra gas that was burned.

In this respect it is also in order to add that the supposed economy of saving the window washers' wages is more than eaten up by the additional burning of gas or other illuminant. In one instance that came under my notice, the economical disease had "struck in" to the extent of using little lard oil lamps for shop illumination on some nice work, and within the past year, too, while within the portals of the office the flicker of the gas jet held sway—economizing where the nice accurate work had to be done, and using gas to copy letters and sign bills by. It is safe to say that it would have been far cheaper to have shut the shop up as soon as it got too dark to work by daylight, than to have attempted to do good work by the lamps, as the men could not see, and did not feel inclined to strain their eyes in trying to. The incandescent lamp where minute subdivision is considered necessary, and the arc lamp where large areas are to be lighted, seem to afford the best means up to date, and by using the low tension alternating current, the benefits of lamp regulation, as to the amount of light emitted, without useless waste, can be obtained, although there are few places where full light is not wanted when any is desired, and unfrequented rooms and closets can be provided with a lamp controlled by a push button or switch from the outside. For general lighting, the arc lamp is growing in favor, and on the Continent is said to be very successfully employed in this capacity by being burned in an inverted position, throwing the rays of light to the ceilings, which reflect it down again without shadows, and in the best manner possible, the ceilings and walls being painted a very light color for the purpose.

Next to economy in lighting a shop, the heating problem demands attention, and on the solution of this, as well as the other, depends to a certain extent the economy of the shop, for men cannot work well with cold hands and feet any more than they can with the lard oil lamps. In this same shop where the lamps before mentioned prevailed, the heating system was simply a centrifugal fan in the engine room, which discharged heated air into one corner of the shop (which was a building about 60 by 150 feet) and as a consequence the heated air either got tired or lost before reaching anywhere near the lower end of the shop. And as soon as the upper end got warm enough for the men there, the trap door would be shut and the supply of heat shut off, so that it would be nearly noon before the lower end got in shape to work, though this was the end where the nicest work was done. In this lower corner the writer has seen the thermometer below the freezing point when the whistle blew for 7 o'clock, and the condition of men's hands for fine work at this temperature can be imagined as well as described. Yet the cost of piping the hot air around the shop or of heating by steam would have been considered as an extravagance not to be tolerated.

And although this may seem like an exceptional case, there are too many in the older and more conservative (more properly "behind the times") portions of this country, and other methods of economy are equally expensive.

There is a point too often overlooked in designing any new machinery or appliances, and this is in having a list of commercial sizes and prices at hand of anything like screws, taps, bar iron, steel, or numerous other portions which can so often be bought much cheaper than we can make them, if we only prepare for it in the design, and we can save more than we think in this manner. It is no disgrace to the tool maker that he cannot make individual taps of odd sizes as cheaply as regular sizes can be bought when made in quantities on special machinery.

This can be carried into nearly every department, and should be looked after as strictly as possible, as special forms and sizes of bolts and similar parts are much more expensive, and can very often be avoided.

There is much in the economical management of a shop that depends upon the men as much as the foreman or superintendent, particularly in the devising of special tools for rapid and accurate production of work; for the men will often devise those which have escaped the attention of the foreman, although as a rule he has more time to look after these things than the men, and it is more in his line of work. But what will discourage this spirit of improvement in the men of any shop sooner than to have the ideas they have thought out and perfected claimed by the foreman or superintendent as his own, and the office knows nothing of the real inventor's) ability? This is too often the case, and the direct result is that men do not take the trouble to think over new ways of doing work, and consequently lose interest, which is bad for any shop.

This kind of foreman seems to think it necessary to have the higher officials think that everything in the way of improvements in the shop methods is due to him, and does not seem to think that the appropriation of credit for such inventions is just as much a theft as though he had taken any other valuable property.

And it is particularly galling to the real inventor when he hears the appropriator of his ideas explaining the value of them to the higher tribunal of the office, taking the credit therefor, and he powerless to say a word if he values his position; or to have this same man show the real inventor how to operate the device he has invented, in the presence of admirers of the superintendent's ability, but there are cases of this to the writer's knowledge.

It is also questionable economy to have the superintendent interfere with the plans as they come from the drawing room, or to pose as a designer as well as a superintendent, for in too many instances the combination is not successful from a financial point of view. An actual case may illustrate the point better than any imaginary one, and it will be given as a horrible example of what may occur under similar circumstances. We will disguise the superintendent's name by calling him Mr. Lane, and his invention (alleged, though in reality designed by another party several hundred miles away, and who, for a royalty, gives Mr. Lane the honor and part of the profits of the invention) by calling it a doubled barrel air pump, with some very bad mechanical features. The first few machines did not give universal satisfaction, failing to show the economy claimed and desired, and as a consequence Mr. Lane's time was very much occupied with outside work and much other business besides looking after the most economical shop productions, as had been his custom before, and as a consequence there crept into the shop reports that machinery had been sent out which was not up to the usual reputation of the firm. Hitherto Mr. Lane had kept an eagle eye on the work turned out, and nothing but the very best had been allowed to go, but as work must be got out on time, and as his personal attention was needed in many places to make the pumps work satisfactorily if at all, it would happen that some of the parts did not exactly fit, owing to lax inspection during Mr. Lane's absence. This should not have happened, but it does in too many similar circumstances, and besides this the work of the pumps being new, took more time than it otherwise would, and the other work was correspondingly delayed, although night work (the most expensive kind of work generally) was resorted to.

Repairs on pumps which had been sent out before the invention was really perfected (which point has not been reached as yet) and the replacing of worn or broken parts as the guarantee which accompanied the pumps demanded, took time and cost money, besides delaying the other work, and confusion, poor work and other annoyances resulted which all bred trouble in the future. To make a long story short, the time of the superintendent which had hitherto been occupied in improving the shop methods, was now diverted to another channel, and in which was a pecuniary interest, until the shop was almost in confusion, the reported successes of the pump found to be false and the money the experiment had cost gone to the four winds, simply because Mr. Lane had stepped out of his legitimate sphere without leaving another man as superintendent in reality. This story has more than one companion to the sorrow of as many confiding companies. Of course, this may be taken as an assault upon inventions of superintendents in general, when nothing of the kind is intended, for with the right kind of a man they are almost sure to follow; but let him either step out of the

superintendency or else have nothing to do with the commercial side of the invention, but attend merely to the details of making it, letting the firm handle it exactly as their other products, and let it stand its chances exactly as other inventions without any fostering.

Of course, consultation on all points is desirable in any case, but it most certainly pays to have the superintendent attend to his legitimate duty; that of attending to the shop methods for cheapest production, and not have him running around the country looking after a piece of machinery that needs skilled nursing to get it to run at all. If the invention proves of value and it is deemed best to have the inventor look after it commercially, merely get a new superintendent of the right stamp, and create a new position if necessary for the old one, for it pays to have a superintendent who superintends.

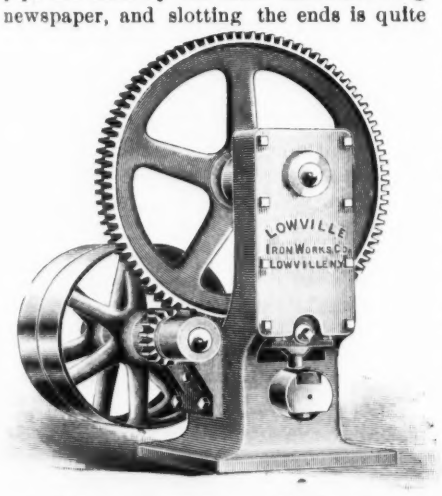
There are notable exceptions to this criticism which need not be mentioned, but it is pretty safe to assert that in such cases, under the guise of assistant superintendent, was a man who, to all intents and purposes, was superintendent, and thus the shop was not without a competent head, although the writer deems it better to call things by their right names, and thinks that the title of consulting or designing engineer would be better in such a case. It must not be understood that the writer thinks all workmen will fall behind in the quality of their work unless constantly watched, for this is not the case; but the lack of a guiding hand, of some one with time to keep track of the work in its different stages and note chances for improvement, is sure to make itself felt, and that on the wrong side of the ledger every time.

Get a superintendent with ability, and keep him in his place, if you want the most economical shop management.

FRED H. COLVIN.

A Special Punching Machine.

In the manufacture of paper when made for use on a continuous web printing press, it is made in rolls, each roll being wound on a piece of iron pipe, which, when prepared for receiving the paper, is known to paper makers as a spool or core; in the end of this piece of pipe is a slot made to slip over a feather on the shaft, which carries the roll of paper on either the paper machine or printing press to keep it from turning, independent of the shaft. A large number of these pieces of pipe are used by the mills manufacturing newspaper, and slotting the ends is quite



A SPECIAL PUNCHING MACHINE.

an item of expense when done in the usual way, a hole being drilled where the end of the slot is wanted and the piece between the hole and end cut out with a chisel. For doing this work quickly and much cheaper the machine shown has been designed; the die is fitted in the end of a steel bar which the pipe slides over, and one stroke of the ram leaves the slot finished. The ram is of the ordinary type driven by eccentric, the eccentric and shaft being made of one piece of hammered steel. Pulleys are tight and loose 12″x4″. It can be placed in any convenient position and driven in either direction. It is made by the Lowville Iron Works Co., Lowville, N. Y.

The Schiele Curve and the Friction of Thrust Bearings.

BY R. E. HORTON.

Among the losses of power due to friction in machinery one of the most difficult to obviate is where a revolving shaft supporting a load presses longitudinally against a bearing. In order to avoid the effect of uneven wear of the center and circumference of the shaft, there have been devised various contrivances, few of which are perhaps so ingenious as the "Schiele antifriction thrust bearing," as it is called from the name of its inventor, Christian Schiele.

The form of this bearing is that of the solid generated by revolving the Schiele curve about its axis.

From one of its characteristics the Schiele curve is sometimes called the curve of equal tangents, but to mathematicians it is known as the tractrix, since it is the curve traced by one end of a line, the other end of which is drawn along a straight line, or the tractrix may be defined as the path of a point, which moves so that the length of the tangent intercepted between the point of contact P and the axis $o\ x$ in Fig. 1 of the curve is constant.

Let $P_1\ T_1$ and $P_2\ T_2$ be the tangents at any two points P_1 and P_2 of the tractrix $m\ n$, then from the definition $P_1\ T_1 = P_2\ T_2$ = constant = a. It is evident from Fig. 1 that the greatest distance of any point on the curve from $o\ x$ is a, hence, the branch $m\ n$ of the curve terminates at A, where $A\ O$ drawn from A perpendicular to $o\ x$ equals a. Also from Fig. 1 we see that a curve might be constructed either above or below $o\ x$, and either to the right or left of $O\ A$, having tangents of equal lengths, that is, the tractrix has four equal branches; we shall consider but the single branch $m\ n$. If we prolong the curve indefinitely to the right, the constant tangent $P\ T$ becomes more and more nearly parallel with $o\ x$, but since the extremity T of $P\ T$ always lies in $o\ x$ the curve must approach more and more nearly to the line $o\ x$, only meeting it at infinity, hence, mathematically speaking, $o\ x$ is an asymptote to each branch of the curve.

There is no correct geometrical method of constructing this curve, and its equation as derived from the definition given above is so complicated as to make it inconvenient, yet it affords about the only means of accurately plotting the curve. I will state it as a rule without the use of symbols, referring to Fig. 2. To find the horizontal distance or abscissa x for a given vertical distance or ordinate y, of a point on the tractrix, extract the square root of the difference between a squared and y squared, and add a to the result, divide this sum by y, and multiply the common logarithm of the number so obtained by 2.3 times a, and from the product subtract the square root of the difference between a squared and y squared, as already found, the remainder is x as required.

For example, since we may give a any desired value, put $a = 1$, and let $y = \frac{1}{2}$; to find x we have $\sqrt{1 - \frac{1}{2^2}} = \sqrt{\frac{3}{4}} = 0.866$, $1 + 0.866 \div \frac{1}{2} = 3.732$, of which the logarithm is 0.57194, $2.3 \times 0.57194 = 1.317$, $1.317 - 0.866 = 0.451$, hence $x = 0.451$ when $y = \frac{1}{2}$, in this manner any number of points on the curve might be found, and the curve drawn through them would be the tractrix in which $a = 1$.

The table gives the co-ordinates of the tractrix where $a = 1$, from it the curve may be constructed directly to any desired size by choosing different scales.

y	x	y	x
0.0	∞	0.6	0.298
0.1	1.997	0.7	0.182
0.2	1.313	0.8	0.093
0.3	0.920	0.9	0.033
0.4	0.651	1.0	0.000
0.5	0.451	$y > 1$	Imaginary.

It may be proved that the length of the curve measured from A to any point whose ordinate is y equals 2.3 times the logarithm of a divided by y; for example, if $a = 1''$ then when $y'' = \frac{1}{2}\ a \div y = 2$, and length = $2.3 \log. 2 = 2.3 \times 0.30103 = 0.''693$.

Some properties of the tractrix are interesting from the relation they bear to the corresponding properties of a circle whose radius is equal the constant tangent a of the tractrix. It may be shown that if the curve $m\ n$, Fig. 2, be indefinitely prolonged to the right, the limit of the area between it and the axes $O\ X$ and $O\ A$ will equal the area of a quadrant of the circle whose radius is a. Again, if we revolve the curve about its

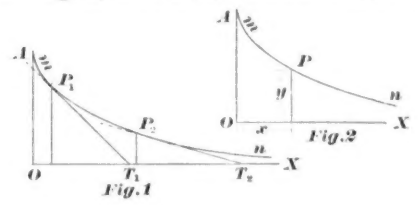


Fig. 1 Fig. 2

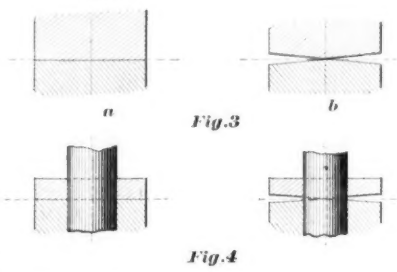


Fig. 3

Fig. 4

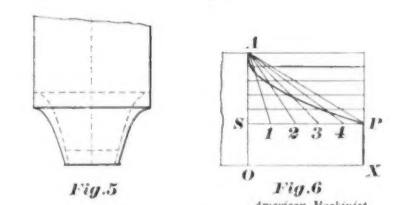


Fig. 5 Fig. 6

American Machinist

THE SCHIELE CURVE.

axis $o\ x$ the limit of the surface of the solid of revolution so produced will equal half the surface of the sphere whose radius equals the constant tangent a, and the volume of the solid will equal in the limit one-fourth the volume of the sphere.

Passing to the second part of our subject, when a revolving shaft exerts a longitudinal pressure, as in the case of a vertical shaft supporting a weight of pulleys and gears, or a worm shaft, the end pressure or thrust is usually taken up by one or more thrust or step bearings, as they are sometimes called; where motion is slow, the wear of a thrust bearing of most any of the ordinary forms will not produce noticeable effect, as in the table of a boring and turning-mill, but where the velocity is relatively great the surfaces in contact wear rapidly, and, as is well known, tend to wear unevenly.

The frictional resistance offered by any bearing is determined by what is known as the moment of friction of the bearing, that is the product of the frictional resistance of the bearing in pounds into the distance from the center of the shaft at which it acts. A force whose moment is equal the moment of friction of the bearing and which acts in the direction of revolution of the shaft would equilibriate the friction of the bearing.

It is shown in mechanics that the moment of friction of any bearing is independent of the form of the bearing, depending only on the outer and inner radii of the bearing and the weight or pressure supported, or as a formula we may write $M = \frac{2}{3} f\ W\ R$ for a flat or conical thrust bearing, and $M = \frac{2}{3} f\ W \left(\frac{R_1^3 - R_2^3}{R_1^2 - R_2^2}\right)$ for a collar or Schiele bearing.

Where f = the co-efficient of friction between the surfaces;
W = the total weight or pressure on the bearing;
R = the radius of the shaft in a flat or conical thrust bearing;
R_1 and R_2 = respectively the outer and inner radii of a collar or other bearing in which the central portion is not in bearing contact.

Example.—If the total load on a vertical shaft is 2,000 pounds, and is supported by a flat bearing whose radius is 2″, the co-efficient of friction between the bearing surfaces being 0.15, then the moment of friction of the bearing will be $\frac{2}{3} \times 0.15.2{,}000.2$ = 400 inch-pounds. The wear of thrust bearings is, according to Rankine, very nearly proportional to the frictional resistance and the velocity of rubbing jointly; hence the pressure remaining the same the rapidity of wear of the surfaces in contact is proportional to the velocity of rubbing. Thus in a flat bearing the velocity of rubbing varies as the distance from the center of the shaft, as a result a bearing originally having flat bearing surfaces tends by wear to become, as shown, much exaggerated in Fig. 3 *b*.

Fig. 4 shows the form of a collar bearing before and after wear has taken place. The difference between the velocities on the inner and outer surfaces of a collar bearing is less than the difference between the velocities near the center and circumference of a flat bearing, the effect of wear being thereby much reduced, although the moment of friction of this form of bearing will in general be greater than that of a flat bearing having the same bearing surface. Of course, the narrower the collar is made and the greater its radius, the less will be the effect of uneven wear.

In the Schiele bearing the amount of wear measured parallel to the axis is the same for all parts of the bearing; hence the effect, it is evident, is to merely shorten the shaft without changing its form in any respect. Proof of this has been given in a simple form in the AMERICAN MACHINIST for May 14, 1891. The dotted line in Fig. 5 shows the form of the Schiele bearing after wear has taken place.

In laying out the Schiele bearing the arc of the tractrix may be constructed accurately by the rule already given. A simpler method is to draw a parabola which will not differ much from the true curve. In drawing the curve it is necessary to know the greatest diameter of the bearing, usually the diameter of the shaft, the length of the bearing, and its least diameter; then in Fig. 6 let $O\ X$ be the axis of the shaft, $O\ A$ the greatest, and $X\ P$ the least radius of the bearing and $O\ X$ its length, draw $S\ P$ through P parallel to $O\ X$; divide $P\ S$ into any number of equal parts S 1–2, etc., and divide $S\ A$ into the same number of parts, from A draw lines $A_1\ A_2$, etc., through the divisions of $S\ P$; a smooth curve drawn through the intersections of these lines, with parallel lines drawn through the division points of $S\ A$, will give the curve required. The curve should not extend beyond the point where the angle included between a tangent to the curve and the axis $O\ X$ is less than the limiting angle of friction, or the bearing will be liable to stick.

The moment of friction of the Schiele bearing is the same as that of a collar bearing under the same conditions, and is less than that of a flat bearing having the same external diameter, but the form of the bearing is unchanged by wear, while in nearly all other forms of thrust bearing the bearing surface tends to become reduced after wear has taken place.

Chicago is getting in earnest over the abolition of railroad grade crossings. By a very decisive vote of the City Council two roads are required to elevate their tracks to the end of abating the nuisance. The work is to be done at the cost of the two railroads (the Lake Shore and the Rock Island). Any land damages arising from a change of the grade are to be borne by the city, the railroads to be responsible for any other damages arising from the passage or operation of the ordinance. The work is to be begun by August 1st next, and is to proceed at the rate of at least one and one-half miles a year. It is understood that the two roads affected will accept the ordinance. The mayor will, it is believed, sign it.

We doubt if an instance can be found in the world, outside the records of transatlantic steamship transportation, in which so many passengers are transported with so few casualties as in the instance of the ferries to and from New York. These ferries afford about the safest means of travel known to the traveling public.

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NEW YORK, MARCH 29, 1894.

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Manufacturing Business Improving.

Those who for the past few weeks may have been noticing the items published by us under the heading of "Manufacturers' Notes," have found there unmistakable evidence of reviving industry, and there can no longer be a reasonable doubt, but that manufacturing activity is returning.

Last week we published extracts from the letters of four different manufacturing concerns, including Eastern and Western tool builders, emery-wheel makers, and a shop doing general jobbing and repair work. All these have experienced a decided improvement, and we know of no better or surer indication of a decided turn of the tide.

Of course, there are still many establishments in which work is far less plenty than we could desire, and there are, alas, many specimens of the genus croaker; but the fact is, nevertheless, that business is improving, and unless some unlooked-for event comes to pass we expect to see it continue to improve.

Locomotives as Stationary Engines.

At the first monthly meeting of members of the A. S. M. E., January 10th, Mr. Geo. S. Strong made some comparisons between locomotive and stationary engines, which seemed to indicate that the builders of stationary steam plants are, as engineers, very much inferior to locomotive designers and builders. Since then these remarks have been quoted by others, who seem to have attached a certain importance to them which, we think, is scarcely deserved when all the related facts are considered.

From what has been said, it is fair to presume that there are those who think that before the builders of stationary engines and boilers can hope to compete, through the medium of electricity, with the locomotive as now built and used for pulling trains, they must practically discard their present designs, and use for, say, a 1,000 to 1,800 horse power plant, something very like the locomotive—a single internally fired boiler with forced draught carrying high steam pressure—up to or exceeding 200 pounds—and using this steam in relatively small cylinders at very high piston speed—about 1,400 feet.

The main object to be attained in all this is reduction in first cost; the gist of Mr. Strong's statement being that: "This question of generating electricity with the ordinary stationary engines to compete with locomotives has this disadvantage, that taking an 1,800 horse-power triple compound Corliss plant, and comparing it with a high class locomotive of the same power, we find the locomotive costs about one-tenth of what the stationary plant costs *to do the same work.*"

From this the inference is fairly drawn that the speaker thought high class locomotives were capable of exerting 1,800 horse-power continuously even up to 24 hours a day, six days a week; because that is just what an 1,800 horse-power plant must frequently do, and is what nearly every such plant is designed to do if occasion requires it. We feel quite certain that no locomotive has ever developed this amount of power for ten minutes continuously, and we very much doubt if any locomotive has ever developed even 1,000 horse-power for one hour continuously. But supposing for sake of argument a high-class locomotive to be capable of developing 1,000 horse-power continuously, and to be in other respects adapted to stationary practice, nothing should be easier than to simply place two connected jack shafts in a pit, provide them with friction wheels for the drivers to rest upon, and then, anchoring a locomotive over them in such a way as to drive the two jack-shafts, use this as a stationary power plant. Such a plant would cost about one-fifth (instead of one-tenth) the cost of a 1,000 horse-power stationary plant. Such a locomotive will have, say, 26 square feet of grate surface, and when being crowded to its full capacity will burn about 150 to 200 pounds of coal per hour per square foot, consuming, easily, about three times as much as the stationary plant will burn for the same power.

Supposing, further, that the locomotive will require per time interval about the same amount of repairs as would be required if it were in service on the road (which is not a violent supposition under the circumstances), it would in about ten years have expended upon it nearly or quite its original cost, whereas a stationary plant would usually cost less than one-fourth as much for repairs in the same period.

It is plain, therefore, that in cost of power delivered to shafting or dynamos, the regular stationary plant would be much the most economical, and this is just what we should think would be expected by any one familiar with such matters who stopped to think that both stationary steam plants and locomotives have been developed tentatively by engineers of presumably equal ability for the two classes, each striving to meet conditions as actually encountered.

Designers of locomotive engines have given relatively very little attention to economy of coal consumption. Their high steam pressures and high piston speeds have been adopted simply to enable trains of given weights to be pulled over roads at given speeds by engines of limited weight. They have met and solved many difficult problems in a very creditable manner, but, on the other hand, the designers of stationary plants deserve equal credit for their solutions of other, and, in many respects, entirely different problems. It is not reasonable to suppose that the machines resulting from the study of these two radically different sets of problems can be interchanged and give satisfaction in their transposed positions, or even that either class of men can copy much from the designs of the other.

Stationary engine builders are as well aware of the advantages of high steam and high speed as any other class of engineers, but their experience has taught them some things regarding limitations, and it is always to be remembered that a stationary engine builder who should put down a plant of 1,000 to 1,800 horse-power, at any cost whatever, that should consume as much coal per hour per horse power as is consumed by locomotives would change his plans or promptly go out of business, to say nothing of the questions of comparative repairs and lifetime of plants.

Of course, we do not mean to convey the idea that Mr. Strong or those who quote his remarks approvingly propose actually to use a regular locomotive engine for a stationary power plant, but a fair inference is that they would expect a locomotive rigged up as we have described to be more economical in developing 1,000 to 1,800 horse-power than a first class stationary plant such as are usually put in for that power. While our expectation is that, in the first place the locomotive as at present constructed would not develop any such power continuously at any cost, and that in order to make it do so its design would have to be changed, after which considerations of economy would force other changes in design, with the final result of having a plant fully as expensive in first cost as are the present stationary steam plants.

Another phase of the question bearing upon competition between locomotives and stationary plants is to be found in the fact that while if there were but one train to be operated upon a road, a stationary plant to pull the train by electric motor would have to possess as great power capacity as a locomotive to pull the same train, a stationary plant to develop electricity for a dozen trains would not need to possess nearly so much power capacity as would have to be possessed by the twelve locomotives to pull the same trains. Just how much less power it would need would depend somewhat upon local conditions, and there is no very definite knowledge regarding the matter, but it is significant that the engineers of the Intramural road, at Chicago, though experienced in electric traction, very greatly overestimated the amount of power required for the road, and, judging as best we can from their experience, we should say that the steam plant to operate by electricity such roads as this form of propulsion is adapted to will actually cost considerably less than locomotives to pull the same trains, instead of ten times as much.

The old-time method of stating the efficiency of a steam plant was by considering the engine and boiler as a unit. In the modern method engine and boiler are considered as separate units. This has come about largely, no doubt, from the fact that it is nowadays the rule rather than the exception for one builder to furnish the engines, and another the boilers. The economy of engines in large plants has come to be a matter of considerable competition, and the engine builder, instead of guaranteeing pounds of coal required, guarantees pounds of water, or if the guarantee is pounds of coal, it is based on a given boiler efficiency. When it is expected that a guarantee shall divide pounds, the engine builder does not propose to be handicapped by the performance of boilers he did not build. In the actual use of boilers and engines this may not always work as well as the old plan. Sometimes it is rather apparent that, it having been determined that the engine works with water away down to fifteen or sixteen pounds, very inefficient boilers are kept in use, the pride in the matter being mainly centered on the engine. But that must be left to itself, both engine and boiler builder taking care of their individual parts of the contract.

American Pig-iron in England.

An announcement of considerable significance comes from Birmingham, Alabama, which is to the effect that 200 tons of Birmingham pig-iron has been shipped, *via* Louisville & Nashville Railroad, to the Southern sea-board, and from there will go to Liverpool, England, meeting there, of course, the competition of iron from every other part of the world. This shipment, it is understood, follows an experimental shipment made several weeks ago, and it is said that arrangements have been made both with the L. & N. road, and with a steamship company for frequent shipments of the same kind to the same port.

There will be, of course, no difference of opinion as to the desirability of low cost of raw materials of manufacture, and it is a subject of congratulation that the natural conditions are such that in the South iron can be produced at a very low cost.

As to the advantage to be gained by exporting raw materials of manufacture, there is, however, a difference of opinion, there being those who think that any thing whatever that tends to make "the balance of trade" in our favor is advantageous, while there are others who think that all the iron, coal, lumber, etc., shipped abroad, is that much of our material resources gone, and that we can never receive any adequate return for them. Whichever view of the matter may be taken, the fact remains that our shipment of pig-iron to England reminds one of "carrying coals to Newcastle," and is a remarkable change from the conditions of a very few years ago.

When the bridge between Brooklyn and New York was projected it called out a great deal of comment. Now there is little doubt that, before long, there will be several "Brooklyn" bridges. Not only this, but there will be several bridges between New York and Jersey City, across the North River. The latest move in this direction is by the P. R. R., and this will, beyond all reasonable doubt, materialize.

In European countries the effort for electrical propulsion of cars is through the use of storage batteries or the underground conduit. In this respect greater progress is being made there than here. The overhead trolley system must eventually disappear except in purely suburban traffic.

The "Parisian Inventors' Academy," is the impressive title of an institution in Paris, with, apparently, a most imposing list of officers and committees—distinguished men, all—and which offers to inventors its "first-class diplomas and the great gold medal (gilded)" as well as the title of "Member of Honor," on receipt, from the simple and easily gulled victim, of ten dollars in gold, ungilded. This is the concern which was looked up in Paris, two or three years ago, by Mr. Theodore Stanton, the well-known writer, at the request of Dr. Thurston, and exposed on both sides of the Atlantic; but, as in the case of the foundry medicine humbug, which has been so often similarly exposed, the traffic with "lambs" still goes on.

Mr. Egbert P. Watson, of the *Engineer*, is just now enjoying a well-earned trip, by steamship, to New Orleans. He will not handle the throttle or manipulate the levers on this little trip, but it will make him think of the time when he did do this. It will drive pages to regulate and corners to fill, out of his mind for a few weeks—break up the monotony that kills—and bring him back about ten years younger.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(149) C. E. L., New Britain, Conn., writes: Please give me a formula for making silver, both hard and soft. *A.*—Silver is not made, it is an elementary metal.

(150) E. T., New Stanton, Pa., writes: Please give the name of a book treating on testing samples of lead, copper and silver ores; also, how to determine whether certain samples contain either of the above minerals? *A.*—Literature on this subject seems to be scarce; we have not seen a book treating on this subject that we would care to recommend.

(151) J. D. P., Boston, Mass., writes: Please inform me if there are any books containing the results of experiments made by Messrs. Wilfred Lewis and J. S. Bancroft referred to by F. W. Taylor in his "Notes on Belting," published in your issue of January 18th, current volume? *A.*—Mr. W. Lewis contributed a paper on this subject to the American Society of Mechanical Engineers, which has been published in their yearly reports of transactions.

(152) J. B., Peterboro, Canada, writes: Kindly mention a few books suitable for a young man to study who intends to become a stationary engineer. *A.*—J. Bourne's "Catechism of the Steam Engine;" "Elementary Manual on Steam and Steam Engines," by A. Jamieson. You may find that in studying these books you have not sufficiently advanced in the study of arithmetic, geometry and mechanics; if this is the case, study those text-books which are used in your public schools.

(153) J. S., Brooklyn, N. Y., asks: What horse-power can be obtained from an engine with a cylinder 2½ diameter; stroke, 3½ inches? *A.*—With a mean effective steam pressure of 40 pounds, and running at the rate of 400 revolutions per minute, the engine will develop 1 horse-power. 2. Would this engine drive a launch 18 feet long, and what will be speed of the boat? *A.*—The engine is large enough for a launch 18 feet long. The speed depends on the lines of the launch; it may be as low as 5, and as high as 10 miles per hour.

(154) J. M. B., ——, writes: Please explain how to temper circular saws for cutting metals. Also, give name of publication that gives this and similar information. *A.*—One way to temper such saws, especially applicable to very small and thin ones, is to heat them—preferably in a muffle—and then lay them on a block of steel and drop another block upon them. A small drop hammer does the work very nicely. By having the dies cold, they will take the heat from the saw quickly enough to harden it, and at the same time prevent its springing. Our columns contain more information on subjects of this kind than we know of elsewhere.

(155) A. L. C., New Haven, Conn., writes: I have read at various times about the process of making postage stamps, all having been minutely detailed, excepting the gum, which was made of dried potatoes and other vegetables. Now, this may not be in the line of mechanics, but they certainly do use gum, more or less, and it might be interesting to know through the columns of the AMERICAN MACHINIST how this particular gum is made, and what it is made of. I for one should be pleased to get this information. *A.*—We have made inquiries, but it seems that the process of making this gum is so well guarded that it is impossible to obtain reliable information.

(156) W. K. E., Brooklyn, N. Y., writes: 1. Have you published a description of a watch wheel or pinion-cutting machine? *A.*—No. 2. I wish to polish some small pieces having sharp teeth in them without dulling the edges of the teeth. I have tried brushing them with fine emery, but it takes the sharp edges off. I can bring them out a dull white from the hardening, but I wish to get them bright. *A.*—We think this can be done satisfactorily only by a polishing device somewhat similar to that employed for polishing pinions for watch trains. You are probably familiar with these; if not, you can see them in the hands of watchmakers and can find illustrations of them in catalogues of watch tool makers.

(157) A. M. T., ——, asks: 1. Is there a standard for gear teeth? For instance, is a 4-pitch involute gear made the same shape by the leading manufacturers in this country? *A.*—There is what may be considered a standard for this simply because the general use of the B & S. cutters for involute gears makes them nearly all alike. 2. Will a 4-pitch involute gear work into a 4 pitch rack of the same style, whatever the diameter of the gear? *A.*—Yes. 3. In representing small bevel gears on a drawing, which lines are generally used; the outside of the gears, or the pitch lines? *A.*—Usually both lines are drawn, the pitch lines dotted. 4. Can a patent be obtained on an improvement to a patented article? *A.*—Yes.

(158) J. J. H., ——, asks: What taper should be given to ordinary hardened steel lathe mandrils, and at what point should they be standard size? *A.*—Practice differs somewhat on this point. A quite common plan is to give them a taper of about .005 inch, and make them standard at the middle of their length. This allows them to take work varying from .0025 inch over, to .0025 inch under standard size. We think a better plan is to make them standard and of uniform diameter for about two thirds their length, and then taper them up, to, say, .005 inch at the upper end. Whether this is the best plan or not, will, however, depend somewhat upon the nature of the work, and how closely the standard is to be adhered to in reaming or otherwise finishing holes.

(159) B. E., Marion, Ind., writes: Please inform me how to brace a tank 72 inches outside diameter, and 61 inches inside diameter, leaving an annular space of 5½ inches between the sheets. Tensile strength of the material is 60,000 pounds; metal, ⅝ inch thick, steam pressure, 125 pounds. It is necessary to have the stay bolts as large in diameter as possible. *A.*—We presume that the steam is admitted into the space between the two shells. Use screw stay-bolts ¾ inch diameter, placed 8 inches from center to center. If this tank is for any government service, screw stay-bolts may not be allowed; under these conditions use ¾ plain stay-bolts, 9 inches from center to center, with gas pipe ferrules between the shells; these stay-bolts, and also the screw stay-bolts must be riveted over at both ends.

(160) C. J., Cincinnati, O., writes: Please give me a rule for finding the diameters of the driving pulleys. I have a shaft running at 195 revolutions per minute, and the pulley on this shaft is 14 inches in diameter. The countershaft pulley is 10 inches diameter, how large in diameter must another pulley be on this countershaft to run a machine at 150 revolutions per minute? *A.*—We presume that the same belt runs over the 10 inch pulley on the countershaft, and the 14 inch pulley on the line shaft. Under these conditions the countershaft will make $\frac{195 \times 14}{10} = 273$ revolutions per minute. Now for finding the diameter of the second pulley on the countershaft, the diameter of the pulley on the machine should be known, and this you have not given. However, you may find the diameter of the pulley on the countershaft by multiplying the diameter of the pulley on the machine by the number of revolutions per minute it has to make (150 in this case) and dividing the product by the number of revolutions of the countershaft (273), the result will be the required diameter. You will have no difficulty in computing the diameters of pulleys if you remember that the product obtained by multiplying the diameter of the driving pulley by the number of its revolutions per minute, must be equal to the product of the diameter of the driven pulley into its number of revolutions per minute. For very exact work the thickness of belt should be taken into account, but for ordinary practice this may be neglected.

(161) R. J. H., Milwaukee, Wis., asks: What is the centrifugal force in pounds of a 4 ounce weight revolving at the rate of 5,000 revolutions per minute in a circle whose diameter is 4 inches? Please give rule? *A.*—The centrifugal force is 348.34 pounds. The rule for computing the centrifugal force is as follows: Multiply the square of the linear velocity in feet per second by the weight of the body in pounds and divide the product by the radius of gyration, and by 32.2, the result will be the centrifugal force. For many practical problems, the distance from the center of rotation to the center of gravity of the body can be taken for the radius of gyration; in computing the centrifugal force we have taken 2 inches for the radius, and the velocity is that of a point coinciding with the center of gravity of the body. 2. I have the following formula for computing the weight of a cast iron ball: (Diameter of the ball)^3 × .5236 × .26 = weight of ball in pounds. Is this correct? *A.*—Yes, provided the diameter is in inches. 3. I have a reciprocating plate with which I wish to drive some rollers. What metal for the plate would pull the best, insuring a reasonable amount of durability? *A.*—You have not given sufficient data for a correct answer; however, on general principles we should say, steel. 4. What is a safe working pressure per square inch under ordinary circumstances, on babbitted bearings? For instance, what should be the length of a bearing of a shaft 1$\frac{1}{16}$ inches diameter, the total pressure on the bearing is 250 pounds, and the shaft makes 5,000 revolutions per minute? *A.*—For this high speed we should not allow more than 10 pounds per square inch of projected area. The projected area is equal to the diameter of the shaft multiplied by the length of the bearing. Dividing the total pressure on the bearing by 10, we obtain $\frac{250}{10} = 25$ square inches for the projected area, and dividing the projected area by the diameter of the shaft we have $\frac{25}{1.68} = 14.8$ inches for the length of the bearing. Even with this length you may have considerable difficulty to run the shaft with the given load at such a high velocity. 5. It is claimed that when metal becomes heated it will have a greater tensile strength than when cold, say, at a temperature of 60° Fahr. The discussion related to a steam trap, and it was claimed that when heated by a steam pressure of 200 pounds, the cast-iron would not be so liable to burst as when the pressure is applied cold. I do not care to believe this statement until you pass judgment upon it. *A.*—Experiments seem to indicate that wrought-iron has the greatest tensile strength at a temperature of about 394° Fahr. But this is not true for cast-iron, in fact, we are inclined to believe that cast iron is strongest when cold.

(162) B. M. T., Troy, N. Y., writes: We are designing a boiler 59 inches diameter and 24 feet long. It is to have four flues 12 inches outside diameter. The question comes up: What thickness shall we make the flues? Of course, we must depend upon the authorities for data, but this is in the most chaotic state. Is there any reliable data for lap-welded flues above 6 inches in diameter? *A.*—We prefer to use the rules established by the English Board of Trade; these, we believe, have the merit of giving safe results. The following rules are for lap-welded iron flues:

$$\text{Safe working pressure} = \frac{90{,}000 \times t^2}{(L+1) \times D},$$

from which we get,

$$t = \sqrt{\frac{p \times (L+1) \times D}{90{,}000}},$$

in which p = working pressure in pounds per square inch, L = length in feet, D = external diameter in inches, t = safe thickness of plates in parts of an inch. If the working pressure in your boiler is to be 100 pounds per square inch, then the thickness of metal in the flue will have to be,

$$t = \sqrt{\frac{100 \times 25 \times 12}{90{,}000}} = .57 \text{ inch.}$$

The rule established by Lloyd's Registry gives practically the same result. It is as follows:

$$\text{Safe working pressure} = \frac{89{,}600 \times t^2}{L \times D},$$

from which we get,

$$t = \sqrt{\frac{p \times L \times D}{89{,}600}},$$

in which the symbols denote the same quantities as before. Applying this rule to your case we have,

$$t = \sqrt{\frac{100 \times 24 \times 12}{89{,}600}} = .56 \text{ inch.}$$

When the flues are made of steel, the Board of Trade allow an increase of 10 per cent. on the factor given above; while Lloyd's make no allowance for the use of steel, but require the same thickness as if made of iron. Another rule, which makes due allowance for uniform wear of surface, often used by engineers, is as follows:

$$t = \sqrt{\frac{p \times L \times D}{F}} + 2.$$

in which t = safe thickness of metal in thirty-seconds of an inch, L = length in inches, D = diameter in inches, p = pressure per square inch in pounds, and F = a factor, which for iron is 900, and for steel 1,000. Applying this rule to your case we have,

$$t = \sqrt{\frac{100 \times 288 \times 12}{900}} + 2. = \frac{21}{32} \text{ inch}$$

for the thickness of an iron flue. When possible, a thickness of ½ inch should not be exceeded, as there is a strong tendency to burn down to that thickness if the flues are made of thicker metal. Some engineers, however, in spite of this, to avoid stiffening rings, adopt a greater thickness than ½ inch.

Business Specials.

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila, Pa. See p. 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

Chucks, the Nat'l, est'd 1882. 39 Cortlandt St., N. Y.

Speed Gage McLauthlin & Co., Fulton St., Boston.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St. N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Engine Castings, 1 to 6 Horse-power Vertical. Humphrey's Foundry, Bellefontaine, O.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Air Compressors for every possible duty. Clayton Air Compressor Works, 26 Cortlandt street, N. Y.

Steam Pressure Regulators, Reducing Valves, Safety Checks. Foster Engineer'g Co., Newark, N.J.

M. E. Howard, Indianapolis, Ind. Specialty, 4 and 8 H. P. engines in stock, write for price.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

Turning Lathes, Lukin, post free, $1. Lists free. Spon & Chamberlain, 12 Cortlandt street, New York.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

American Packing Rings make pistons steam tight. Are simple, durable and inexpensive; write for circular. J. H. Dunbar, Youngstown, O.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

Grinders' Supplies—Emery, Emery Wheels, Grinders, Knife Powders and Sharpeners, Paste & Liquid Polish, Whetstones. The Tanite Co. New York, N. Y.; Cincinnati, O., & Stroudsburg, Pa.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

The Development of the Steam Engine Indicator.*

The Ferris wheel, with its 250 feet diameter, at the Columbian Exposition, was the Mecca of sightseers, while the location of the marvelous little Linotype was scarcely known. The great wheel was the product of a few months; the Linotype represents the patience, skill and ingenuity of generations; one is big beyond comparison, and appeals through its great tonnage, and the other was lost because of its insignificant proportions. The mission of one is to

* From a lecture by Mr. Harris Tabor, before the Brooklyn Institute of Arts and Sciences.

amuse, that of the other to cheapen and distribute the product of the author's brain, to bring within the reach of all the brightest thoughts and the wisdom of the greatest minds. The great wheel will have no successor, and when its novelty is worn off, will have but little patronage; in a few years an immense tonnage of scrap will be its epitaph. But the little Linotype will continue to respond to every touch on its keyboard, making the best of literature common to all as long as printer's ink is the medium of our greater education. When the great wheel is forgotten, the little machine at the World's Fair, which barely drew a notice from the press, will continue to educate the nations of the earth. It may undergo many changes, but it has the underlying germs of success upon which all future type-making and setting machines must be based.

This disposition to admire the ponderous in size, without regard to functions, is general, and applies to all branches of the arts. It is especially true of the mechanic arts. The tiny watch which we all carry has become commonplace. We no longer marvel over its intricate mechanism, or the skill of its maker, and when the dealer assures us that for a trifling sum he will furnish a pocket time-piece, guaranteed to run 86,400 minutes without departing from standard time more than one minute, we are not even moved to enthusiasm. We accept such perfection as our right without giving a single thought to the centuries of toil, the patience and the brains which have made such mechanical perfection an article of everyday commerce. While we are looking for the mammoth we miss the small products of skill which make the mechanical world wonderful.

Among the little things which have done much to make the closing years of the Nineteenth Century busy and progressive beyond precedent may be classed the steam-engine indicator. This little instrument is nothing in itself; without the steam engine, whose needs brought it into existence, it is as valueless as the Linotype without the printing press.

When that great engineer, Watt, was going through his early career as an engine builder, there was but little known of the laws governing steam. In a general way he knew the source whence his power came, and that it exerted a force against the piston in his engine, but beyond that he was in the dark. He had no way of measuring the power delivered by his engine except by comparison with the horses he displaced, and this could be done only after the engine had performed its work. From one experience he could build a similar machine which would give like results if all the conditions were the same. But the net work accomplished by his engine gave him no conception of the gross power exerted by the piston, consequently he was ignorant of the frictional resistance of the moving parts, and thus each new size became, to a certain extent, an experiment. If he could know how nearly the pressure of steam in the cylinder approached that in the boiler, and could get a record of pressures against the piston throughout its stroke, he would substitute certainty for doubt, and would be able to calculate, with an approach to truth, the results obtainable in the way of power from each engine. He might do more; he could separate the net power delivered by the engine from the gross power applied to the piston, and establish a ratio of frictional losses which would assist him in all future designs. The genius of Watt was equal to the demand. He invented a crude instrument for recording the pressures of steam against the piston throughout its stroke, which contained the germ from which all succeeding indicators have grown. Watt so fully realized the importance of the indicator in developing his steam engine, that he kept its existence a secret until a short time before his death.

It rarely falls to the lot of man to invent and develop a new machine single-handed. The master mind may discover the need which calls for invention, and his conception may indicate the underlying principle of success, and the machine will do just what was anticipated. But the industrial arts are progressive also, and the needs of to-day are supplanted by the greater demand of to-morrow. Under the impulse given by the inventor's creation, progress demands more than the original design anticipated, and an improvement is imperative. New skill and ingenuity are called into play, and the original machine is re-designed and re-invented until the highest perfection is reached. In great inventions the originator always leaves indelible finger-marks in the way of life-giving functions, which no amount of improvement can obliterate. This is true of the indicator of Watt.

Early in the history of steam engineering it was found that the long, tremulous spring and sluggish moving paper-slide of Watt's indicator would not respond promptly to the movements of the steam-engine's piston. There was demand for a better instrument, which McNaught supplied by making the pencil movement of Watt lighter, and substituting a rotating paper drum for the slide. This newer instrument, inefficient as it would seem to-day, marked the beginning of the second era in steam engineering. The knowledge obtained through its use was a prominent factor in re-designing steam ports and pipe areas, and tended to increase the rotative speed of engines, thus giving greater power for a given cost. The McNaught indicator remained the standard for years; too long, in fact, for the best interests of steam engineering. It was not reliable for power measurement except at very slow speeds, and in such cases was too rarely used. As engine speeds and steam pressures were increased, the need of a better indicator was felt, and numerous attempts were made to produce one which would respond to this new demand, without success, until Mr. Chas. T. Porter astonished the engineering world with his theories of high rotative speed in steam engines, which he had already reduced to practice.

Mr. Porter's new departure was more than change; it was radical revolution in the estimation of his most sanguine friends, and rank heresy to the conservatives. Mechanics would not believe it possible to combine such speeds with durability, and few engineers looked upon his system as the birth of a new era in steam engineering. The prejudice against such rapid rotation was so great that a man less able and enthusiastic than Mr. Porter would have met utter failure.

Mr. Porter's engine was constructed on scientific principles, based on a given initial steam pressure and pre-determined point of cut-off. He could assume the pressure and cut-off, but with any instrument at his command he could not measure it. There were frictional losses from the flow of steam through pipes and passages which must be gauged, otherwise his scientific calculations would come to naught. He must know the extent of these losses in order to compensate with larger areas. Here was another demand for change in the indicator, quite as imperative as any which preceded it—a demand which insisted upon a distinctly different type of instrument. This change meant more than fame to the inventor—it meant also the immediate success of Mr. Porter's engines, and an impulse to civilization.

Prof. Chas. B. Richards, of the Sheffield Scientific Department, Yale College (then a mechanical engineer for the Colt's Arms Co., Hartford, Conn.) became interested in Mr. Porter's work and his want of a better indicator. He decided to make one, and for the first time in the history of this little instrument mathematical calculation assisted in its design. Professor Richards analyzed the old before he began the new. He saw that inertia was the relentless foe to quick motion of the pencil, and if lines free from vibration were to be made this must be reduced. Retaining only the piston and spring of Watt, and the paper drum of McNaught, he began his work. The long spring was abandoned and one much shorter and stronger was substituted; a larger piston, with lessened stroke, displaced the old; the new pencil movement, much lighter, was given an increased travel by means of multiplying levers, and the curved line described by the multiplying device was made straight by an ingenious parallel motion. Every part of this invention of Professor Richards showed rare ingenuity, thought, and, best of all, mathematical calculation. It was an ideal combination which retained the life in the old, and introduced new functions which will always be the base work of steam engine indicator construction.

The name of Richards will always rank with Corliss and Porter as inventor and pioneer in steam engine construction. Each has left marks of genius and skill which will have influence as long as steam is the great prime mover of the world. Mechanical construction must change, in obedience to the insatiable demand of progress, and in a few years only the functional parts invented and introduced by the originator remain. The Richards indicator, like the Watt and McNaught, had its day, but its influence was more decided. The greatest impulse ever given to the science of steam-engine construction came through the Richards indicator.

Mr. Porter's success with his high-speed engines encouraged him to still greater speeds, and other builders who were familiar with his practice gradually marked up their revolution list until the heavy parts of the Richards indicator refused to respond, and the various types now on the market came forth. In all these more modern indicators are used the larger piston, stronger spring and multiplying lever, constrained to give the pencil a parallel movement, first introduced by Professor Richards. The mechanism of the newer instruments differs from the Richards principally in the parallel motion, which is much lighter and susceptible to higher speeds.

During the years of growth which have brought the indicator to its present state of perfection, the steam engine reached its zenith in rotative speed. The era of extremely fast running has passed and a tendency to a slower turning speed on the part of engine builders is noticed. It does not now seem probable that a design looking solely to an adaptation to faster speed will again be a problem for the indicator maker, but it is probable that he may meet a demand for an instrument which will make a larger "card," and this demand may be so imperative that a new type of indicator must follow.

This little instrument—which may be covered by a man's hat—has exerted, directly, an influence on the industries and commerce of the world, and indirectly on civilization, which is hard to estimate. Wherever steam engines of any type have been built the indicator has been the engineer's guide. Every advance in construction tending to better steam distribution has been the result of its teaching; all formulæ governing ratios of pipe area to piston and economical expansion of steam have been determined from its diagram, and from the lessons thus taught the world has been the gainer. Its usefulness has not been confined to improving the steam engine. It is as much the standard of measurement for steam power as the grocer's scale is for sugar or the merchant's yard stick for muslin, and it measures cost of power as well as quantity.

It is interesting to note the position this instrument holds in the commerce of steam engines. It is an adviser with unerring judgment. If a mill or factory owner wishes an old engine replaced with a larger his indicator gives him a statement, through its diagram, of the amount of power he is using, to which he may add for deficiency or increase of plant. With this information to guide him, he solicits tenders from engine builders to furnish him with an engine which shall deliver the required amount of indicated power, with a guarantee of the cost of each horse-power, per hour, in pounds of coal or steam. When the engine builder furnishes the entire steam plant this guarantee of economy is based on coal, but when the old boiler is retained he cannot assume responsibility for what he did not supply, and steam consumption becomes the standard of economy. When the engine is put to work in the factory, a test is made to determine if the builder has fulfilled his contract. An indicator is attached to the engine's cylinder and diagrams are taken at intervals of a few minutes through the day, and the coal or water used weighed. From the diagrams taken the horse-power developed by the engine and the steam or coal consumption are calculated. So unerring is this little instrument that an appeal from its decision is very rare.

It might seem that the engine builder, in guaranteeing to furnish a given amount of power, with a limit to the cost of coal per unit of power, was taking a serious risk. But this is not so. His indicator has taught him all the elements of economy and how to control them; it has taught him the shape of the diagram which gives the best results, and he has only to construct such a diagram, theoretically, and build his engine to it.

Our modern ocean greyhounds are marvels of size, speed and beauty. We look upon them with amazement, thinking only of their huge architectural proportions, with never a thought of the details, which are the arteries of these great ships. We are familiar with steam engines on land which will indicate horse-powers in hundreds, and occasionally we find one which delivers to the wheels of industry these units in quantities of 2,000 and, exceptionally, 4,000. These are our land giants. On board those monster ships, the "Campania" and "Lucania," away down below the level of the sea is stored a power such as the world has never before seen, and of which Watt never dreamed. A power which handles 13,000 gross tons as a child would a toy; a power which forces this great bulk and weight through 3,000 miles of sea at railway speed. These immense engines of power grew under the direction of the steam-engine indicator. Before the ship's keels were laid, before the first line marked the drawings from which these engines were built, theoretical indicator diagrams were plotted by the designer for each cylinder, and these plotted diagrams laid down the law which he must follow. These engines must do more than furnish the required 27,000 horse-powers to give these great ships such phenomenal speed. Commercial success demanded that they have a carrying capacity beyond their immense coal tonnage, and the designer plotted his theoretical cards with a view to getting the highest steam economy along with the greatest power.

In all parts of the world where the steam engine has promoted industrial growth and encouraged civilization the little steam engine indicator is known. There is not a branch of steam engineering which has not felt its influence and responded to its teaching. Like many other little things which we pass by as insignificant it has done much toward revolutionizing the industrial world. Its use has become common, and instead of being confined to the few it is now a part of the engine room equipment. Its extended use must continue to improve that greatest of all inventions, the steam engine.

There are two essential movements in steam engine indicators; first, that of the piston which is exposed to atmosphere and spring resistance on one side, and the pressure of steam in the engine cylinder on the other side; and, second, that of the paper or card drum which takes its motion, in one direction, from the crosshead or other part of engine moving co incidentally with the piston and is returned by a spring. These movements are at right angles, and when made in unison produce an indicator card. The steam resisting springs are accurately made to scale, so that each inch of pencil movement represents a given pressure in pounds per square inch on the engine's piston. The principal difference in the construction of indicators lies in the multiplying device and mechanism for giving parallel motion to the pencil.

No. 1. Watt's indicator, now on the screen, contained the two functional movements, but lacked all other elements of success. The heavy piston, resisted by a long, tremulous spring, and the pencil moved with the same velocity, and the inertia due to the weight of these parts, made the lines of the diagram wavy and irregular in the extreme. The paper slide was clumsy, and being returned by a weight its limit was soon reached. Such an indicator would now be considered useless, but it must always have an interest, as the seed from which modern indicators have grown.

No. 2. The next indicator in order, and now before you, is the Richards. Here you see the larger piston with reduced travel, and the multiplying lever for giving the pencil a greater movement than the piston, in combination with a parallel motion to the pencil. This instrument, in its day, seemed perfect, and for years was the only standard. But as the demand for higher rotative speed in engines increased, the number of parts in the Richards parallel motion proved too heavy for good work. The Buckeye Engine Company were among the first to feel the need of a lighter instrument, and their engineer, Mr. J. W. Thompson, brought out the Thompson, which you see.

No. 3. The main difference between the Thompson and the Richards lies in the parallel motion. In fact, this may be said of all the indicators now on the market.

Here, you see the levers and link in the Richards dispensed with, and a single multiplying lever, constrained to move its pencil end in a practically straight line, by a short link. Thompson reduced the number of moving parts in the pencil mechanism of Richards, and consequently their weight, and produced an instrument susceptible of higher speed. It is interesting to note that Watt not only invented the first indicator, but he used the parallel motions of Richards and Thompson in his early steam-engine construction.

No. 4. The Tabor, made by the Ashcroft Manufacturing Company, differs from all the others in its method of obtaining parallel motion. The usual retaining link is dispensed with, and in its place is used a curved guide into which runs a neatly fitted hardened roller, attached at the proper point to the pencil bar. This device gives a straight line to the pencil throughout its entire range.

No. 5. The Crosby is similar to the Thompson in its parallel motion. It uses the single link which is attached to the connection between the piston rod and pencil bar instead of to the pencil bar, as in the Thompson. The Crosby is a smaller instrument than the others, being only about three-quarter size. It is probable that its parallel motion reaches its limit earlier than the Thompson, hence its reduced size.

No. 6. The indicator is always truthful if properly used; but if carelessly used it is often a liar without conscience. In attaching it to an engine the utmost care must be taken to see that the motion of the paper drum is a correct reduction of the motion of the engine's piston. There are various reducing motions for this purpose, consisting of wheels, pantographs, and the more crude affair commonly called lath. The pantograph, in the form called lazy tongs, is one of the oldest and one of the best. As seen before you, the pantograph is attached to an engine, and connected to a pair of indicators, so that the motion is reduced about three-quarters.

No. 7. The next view shows another form of pantograph, designed by Mr. Geo. Barrus, which gives a perfect motion to the indicator. It is light and portable, and easily attached to an engine.

No. 8. The Brombaugh arc which you now see, while not perfect in its reduction, is near enough for ordinary purposes. It is usually a makeshift when other methods are not at command. In using this form care should be taken to see that the arc is supported, so that it cannot yield under the tension of the indicator cord.

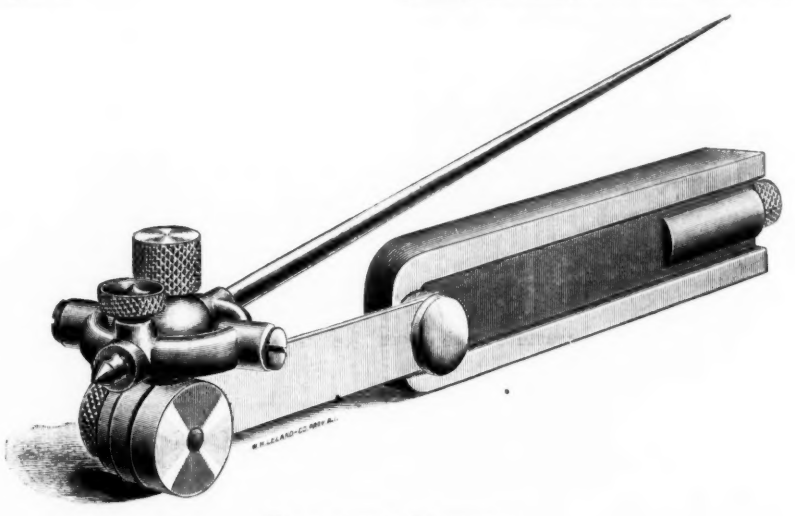
No. 9. The diagram, or card, is the language of the indicator, which is always interesting to the engineer. The first of the series of cards illustrated is an ideal one which shows all the distinctive features of the indicator card.

[From this on the lecturer showed through projections on the screen various indicator diagrams from different types of engines and explained the signification of the different lines, and the graphical manner in which the indicator showed the comparative economy of different ways of using steam, concluding his remarks by illustrating the importance of proportioning steam passages to speed.]

Combination Indicator.

The following illustration is of a tool designed for a center indicator, for testing the truth of work in the lathe from a center punch mark located thereon, also for testing the truth of a hole or shaft.

It consists, as shown, of a holder to clamp in tool-post, to which is attached a flat spring by friction rivet. A partially split hub or nut is clamped to the outer end of spring by a knurled screw, the head of which is shown in lower left corner of cut. A ball is journaled to this split nut by the vertical knurled screw. This arrangement allows of clamping the vertical screw on its thread end, when side screw is tightened, so it will not become loose when ball is oscillating upon it.



Combination Indicator.

A ring in indicating needle is pivoted to the ball by two pointed screws, the whole completing a gimbal joint when vertical screw is sufficiently loosened to allow the ball to oscillate, but when vertical screw is tightened it clamps the ball to the split nut and then the needle can only oscillate vertically, which is for the shaft or hole feature.

A bent tip is furnished for use when the tool is used as a shaft or hole indicator, which can be quickly substituted for the center shown and may be kept, when not in use, in a hole provided for the purpose in back end of holder. The tips being made of standard $\frac{5}{32}$ steel wire, and held in the tool by a knurled thumb-screw, a special shaped one may be readily made to suit the work in hand, if required. The flat spring, besides making the tool sensitive as a center indicator, so as not to damage the center in work, or accidentally drop out, is of great advantage in enabling the correct vertical adjustment to be made independent of the tool-post. This is an essential feature, especially in truing shafts or holes.

With the needle furnished it magnifies about 12 times.

The holder and ring are malleable iron, nicely japanned, all other parts being finished.

All necessary parts are hardened, making the tool durable as well as neat looking, and convenient for its various uses.

It is made by J. T. Slocomb & Co., Providence, R. I.

It seems likely that the new small arm for the navy will have a barrel of "nickel steel"—about 95 per cent. of steel and 5 per cent. of nickel. It is thought that barrels made of this will not only have the advantages of strength (or of lightness) indicated in a former issue of this paper, but that such an alloy will better resist the action of salt spray than will clear steel, and, of course, this is of itself an important advantage for a naval arm. Some experimental barrels have been made and are to be tested.

Antwerp International Exposition.

We have received the following, with a request that we publish:

At a meeting of the members from New York, of the U. S. Honorary Commissioners to the Antwerp International Exposition, held at their offices, 14 and 16 Church street, N. Y. City, on Wednesday, the 14th inst., it was resolved to again call the attention of American manufacturers and producers to the fact: That the Antwerp Exposition will open promptly on the fifth of May next. This is assured, as all the main buildings of the Exposition are now completed. Intending exhibitors (and especially those from the State of New York) are urged to make their applications for spaces or concessions immediately; if possible, before April 1st, at the New York Headquarters.

For our manufacturers and producers who are now seeking the markets, not only of Continental Europe, but of Latin-America and Australia, exceptional opportunities can be had at the Antwerp Exposition, for placing the samples of their goods before the buyers from these markets, because this is a business Exposition.

The representatives of the Honorary U. S. Commission will (where such services are required) have the general supervision of the reception and care of exhibits during the term of the Exposition. Exhibits should be ready for shipment not later than April 10th. Special low rates for shipments to the Exposition direct have been obtained.

For further particulars, apply to the N. Y. Headquarters, Antwerp Exposition, 14 and 16 Church street, N. Y. City.

T. A. Matthews,
Commissioner.

As a result of the recent experiments made with electricity as a motive power on the Erie Canal, a company organized for the purpose and closely allied with the Cataract Construction Company has secured a franchise which gives it the right to put up the necessary apparatus and supply electric power for towing canal boats. It is specified that the use of the canal as at present (by horses) is not to be interfered with, and that the maximum charge per "electrical horse-power"—which ought to be the same as any other horse power—shall be $20 per season, which is stated to be far below the cost of horses.

There are those who seem to be apprehensive that this may mean in the end the practical exclusion of the horse from the tow-path; and, coincident with his banishment, the robbing of the canal-boat captain of his independence. It is pointed out that this once accomplished, a "mutual understanding" between the electric traction company and the railroad companies who compete with the canal for freight business would be all that would be needed to effectually crush out this competition. We are not particularly apprehensive of this, but the matter will probably bear watching.

The same company is to supply electric current for lighting in towns adjacent to the line of the canal and will light all locks free of charge.

The Pratt & Whitney Company in New York.

The Pratt & Whitney Company, of Hartford, have opened a New York headquarters in the city of New York, at No. 138 Liberty street, which is in what is known as the machinery district, and, in fact, is in the same room with the Niles Tool Works New York headquarters.

The great number of manufacturing establishments in and around New York, together with the fact that it is becoming constantly more and more of a machinery headquarters, has made this move advisable, and in selecting a man to look after their interests here the company have been wise enough to select an expert practical mechanic in the person of Mr. S. T. J. Byam, who is well known in watch manufacturing circles especially, having been connected, in positions of responsibility, with the Waltham, Trenton and other watch factories. A considerable stock of machine and small tools has been put in, and it is the intention to be able to supply at once any of the small tools made by the company. This will prove very convenient for shops in or near New York which have heretofore had to wait three to five days for a shipment from the shops in Hartford.

We shall expect that the new store will prove a good thing, not only for the P. & W. Co. but for all who use tools in or near New York.

Large Lenses.

A lens for refracting telescopes has been devised by Louis Gathman, of Chicago, which, it is stated, bids fair to overcome the difficulties which have been encountered in making large refracting lenses and to allow them to be made of almost any desired aperture.

The difficulties referred to have been mainly connected with the casting of a perfect disk of glass of the required dimensions, the least fault occurring anywhere—even one imperceptible by ordinary visual inspection—rendering the glass absolutely useless.

Mr. Gathman's plan is to make a lens of any required dimensions, composed of relatively small circular pieces set in what may be called a frame which forms a series of black and opaque partitions between the different parts of the lens. The lens so built up is then formed and ground in the same manner as though it were composed of a single piece of glass, the result being that each piece takes the light falling upon it and concentrates it at the common focus, the black, opaque partitions preventing interference between the different sections.

It is, of course, not yet known what the possible limit of diameter may prove to be with this system, but there are those who think that very great things are to result from the discovery.

The fact that men become more careless the better they become acquainted with a dangerous occupation, was forcibly shown by the death of Arthur L. Reese, chief electrician of the Maryland Steel Co. He was to deliver a lecture on electricity, and was killed while making his apparatus ready.

The frequent occurrence of explosions of gas under the streets and sidewalks of cities points out that gas companies should be compelled, by law, to lay their pipes more securely. There is no reason, in sense, for such explosions.

Wall street is probably the greatest railroad center in the world.

An Altoona (Pa.) dispatch of March 20th says: Early this morning 300 men marched to the Red Bridge, about two miles below this city, and compelled the Italians employed there at 75 cents per day on the Bellwood extension of the Altoona & Logan Valley road, to cease work and flee to the hills. Next the crowd proceeded to the Elizabeth furnace, where about 60 Italians were employed, and compelled them to leave. One Italian was shot in the neck.

The next point of attack was Bellwood, where all foreigners found were driven out. Then the mob, now fully 3,000 strong, returned to Altoona, proceeding at once to the Italian colony, with the avowed intention of ridding it of its inhabitants. General Superintendent Sheppard, of the Pennsylvania Railroad Company, forced his way into the crowd, giving his assurance that none of the foreigners would receive further work. He also promised that Americans would be employed by the Altoona & Logan Valley Company and its contractors if violence were not resorted to.

Sheriff Hughes and Mayor Hoyer addressing the mob in much the same strain, the backbone of the proposed riot was broken, and the crowd gradually dispersed.

An endless chain in a manufacturing establishment in New Jersey has, within a short time, come very near killing three men on different occasions. Query: Would the company operating it be held in damages for loss of life from this trap?

Is there any one in the world who reads what a manufacturer says in the way of disparaging the product of a competitor? Is there any one who fails to read what he says in favor of his own product?

MANUFACTURES

Friendship, N. Y., is talking of putting in waterworks this season.

The Isabella Furnace Co., of Etna, Pa., has started No 3 furnace.

The city of Elizabethtown, Ky., contemplates erecting an electric light plant.

Carlson & Anderson are rebuilding their machine shop recently burned at Austin, Minn.

The Mann Vise and Clamp Co., of Cleveland, O., will shortly build a foundry and factory.

At Cochran, Ga., Wm. H. Mobley is trying to secure the erection of an electric light plant.

The Winship Machinery Co., Atlanta, Ga., has put its plant in operation with 150 workmen.

Senter Bros., Dalton, Ga., are erecting a machine shop, and will manufacture boilers, steel clarifiers, mixers, evaporators, etc.

The B. & A. R. R. Co. will erect its car repair shops at W. Springfield, Mass. The plant will furnish work for 200 men on the start.

A site in Pawtucket, R. I., for the American Machine Co., has been decided on, and negotiations completed for a tract of 30 acres of land.

The French-Wiggins Engineering Co., of Little Rock, Ark., has been incorporated, for the purpose of conducting a general foundry business.

F. E and J. M. Church, Angelica, N. Y., will put an electric light plant in their mill soon, and will furnish lights and power to outside parties.

A private company will put a system of waterworks in Angelica, N. Y., costing $30,000. Water will be brought four miles from a never-failing spring of pure water.

The iron roof for the new car barn for the Colonial Electric Street Railway Co., of Kingston, N. Y., will be furnished by the Berlin Iron Bridge Co., of East Berlin, Conn.

F. E. Reed & Co., Worcester, Mass., send us their new 1894 catalogue of machine tools. This catalogue is standard size, and the illustrations are first-class, as well as the paper and printing.

The Bradford, Pa., Electric Light and Power Company will build brick walls around their present wooden structure, and put a truss roof over same, when they will tear out the present building.

Mr. Charles P. Adams, of the Adams Boiler Co., Cleveland, O., who has just returned from a two-weeks' business trip in the Middle States, writes us under date March 21st: "I think business is improving."

The Cleveland Twist Drill Co., Cleveland, O., write us: The Cleveland Twist Drill Co. have just had the honor of furnishing the celebrated U. S. cruiser "Columbia" with a full complement of twist drills and tools.

The *Philadelphia Record*, under date of March 17th, says: "The business situation shows further improvement. The industrial output is larger, and the merchandise distribution has increased." This is the general complaint; about this there can be no doubt.

The Monongahela Iron Company, at Pittsburgh, has resumed in all departments. This makes the fourteenth mill that has started up in full lately. The Hainesworth Steel Works have resumed operations in full in all departments. The Charleroi glass plant of MacBeth & Co. will be put in operation April 2d.

Business has improved with the Brady Mfg. Co., of Brooklyn, N. Y., to such an extent that they are running overtime. As this work is largely composed of new lines of manufacture and experimental work, it is particularly significant of returning prosperity.

F. A. Welles, Milwaukee, Wis., manufacturer of small tools for machinists, writes March 16, 1894: "Business is slowly improving in this locality. Real estate dealers that were selling suburban property are seeking other fields now, such as running for aldermen, etc., etc."

"The Eastern Corporation" succeeds to the large and valuable business of the Surbridge Mfg. Co., of Hagerstown, Md., and with practical men as officers, all of the former employes, skilled workmen and heads of departments, expects by reason of larger facilities and greater plant to widen the already large business.

Landis Bros., tool builders, Waynesboro, Pa., have recently received an order for two of their universal grinding machines—large and small size—from a machine works in Vienna, Austria. Also orders from Belgium and England. Their trade on these machines is steadily growing, and they expect to have an excellent trade on them as soon as business fully revives.

The Springfield Machine Tool Co., Springfield, O., write us under date of March 22, 1894: "Our business is improving every day. Our job foundry work is now better than for nine months (which is a good barometer of the iron trade). We are now marketing all our machinery direct, and are running the machine shop on orders, and the indications point to a satisfactory future."

Baker Brothers, Toledo, O., have issued a new catalogue illustrating the Colburn key-way cutter, which was illustrated in our columns last year. The catalogue is standard size and very completely illustrated. The last two pages are devoted to a consideration of standard dimensions of keys and key-ways, with a full-page table. Any of our readers who are interested in this subject can obtain this catalogue free by writing for it as above.

The Berlin Iron Bridge Co., of East Berlin, Conn., are doing considerable iron bridge work at the present time. Among other contracts, they have seventeen signal bridges for the Boston & Maine Railroad; two bridges 200 feet long for the town of Roxbury, Conn.; a bridge 400 feet long across the Connecticut River, at Stratford, N. H.; a bridge 350 feet long at Turner, Me.; a bridge 260 feet long at Houlton, Me., and a bridge 200 feet long at Moosup, Conn.

All departments of the Pennsylvania Steel Works have resumed work for the first time in three months, employing more than 4,000 men. The Pennsylvania Bolt and Nut Company's works, the East Lebanon Rolling-mills, and the Lebanon Rolling-mills, at Lebanon, Pa., have also resumed operations. The Pioneer and Lee Manufacturing Company's knitting-mills, at Amsterdam, N. Y., are going again after three months of idleness.

The Belknap Motor Company, Portland, Me., find their spring business opening with a rush. The Bishop Gutta Percha Company, of New York City, have just placed their order for two 10 K. W. generators, one 10 horse-power motor, two volt meters, and two ammeters; the Union Mutual Life Insurance Co., 10 horse power motor and elevator; Milliken, Cousins & Short, 5 horse-power and 3 horse-power motor. Estimates have just been put

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To whom it may concern: I hereby advise all persons and companies to have the

Mason Regulator Co.'s Depth Gauge

as I have had the best of satisfaction from them, and hope companies will not be deceived by imitations.

Chickasaw, Ala., Oct. 16, 1893. (Signed) Geo. Lang, Jr.

(To MASON REGULATOR CO., Boston.)

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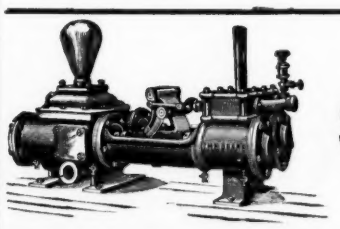

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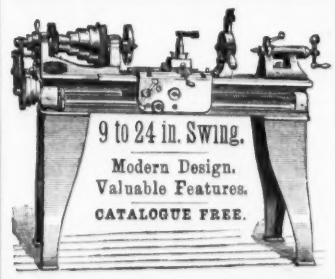

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in for two 1,250 light, and one 200 light dynamos for Washington, D. C.; two electric cyclones have just been shipped to Washington, D. C., one to Philadelphia, one to Springfield, Mass., and another to Independence, Ia., besides twenty-five 1½ horse-power motors just shipped to the Howe Scale Co., Rutland, Vt. Other orders have been shipped to Des Moines, Ia., Burlington, Vt., Rutland, Vt., Augusta, Me., etc.—*Industrial Journal.*

The Bussey & McLeod foundry, Troy, N. Y., has resumed operations, after being shut down since Christmas. About 250 men have been furnished employment. The company's Chicago stove works have started with a force of 350 men. Charles A. McLeod, vice-president of the stove company, is reported as saying that should Congress come to some definite conclusion regarding the tariff bill within the next sixty days, the prospects for a fair trade would be good.

Machinists' Supplies and Iron.

NEW YORK, March 24, 1894.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $13.00 to $14.00; No. 2, $12.50 to $13.25; Gray Forge, $11.75 to $12.50. Southern brands of good quality are obtainable at $13.00 to $14.00 for No. 1 Foundry; $11.75 to $12.50 for No. 2, and $10.75 to $11.25 for Gray Forge.

Antimony—The market is steady and quiet. We quote L. X., 9¼c. to 9¾c.; Cookson's, 10c. to 10½c.; Hallett's, 8¾c. to 9c., and U. S. French Star, 10c.

Lard Oil—Prime is quoted at 63c. to 64c.

Copper—The market for Lake Copper is dull. There are speculative offerings for March and April delivery at 9.60c., while 9.30c. to 9.35c. are bid. For spot supplies 9.70c. to 9.75c. is asked, but there are no purchasers at these figures Casting Copper is held at 9.15c. to 9¼c.

Lead—The demand is light, but the market is firm at 3.45c. to 3.50c. for New York delivery. It is reported that several hundred tons have been taken at 3.45c., and this price is still bid.

Spelter—The market is quiet but steady at 3.85c. to 3.90c. Business could be done at concessions from these prices, but holders are not anxious to sell for less.

Tin—The market is dull, speculative holders are asking 19.30c. to 19.35c., but there is an entire absence of business, except in a jobbing way.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

An experienced foreman patternmaker wants sit'n; highest refs. as to ability. Patterns, AM. MACH.

Patternmaker wishes pos., good capable workman. Address BOX 184, AMERICAN MACHINIST.

Wanted—Position as foreman of boiler shop: A No. 1 refs. Boilermaker, 20 Olive St., Lowell, Mass.

Foreman patternmaker, desirous of making a change, well up in bridge, roofing and architectural work. Address 435, AMERICAN MACHINIST.

First-class tool maker, experienced on dies, hardening, case-hardening, moderate wages, distance no object, wants position. N. Y., AM. MACH.

Position wanted by all-around machinist and tool maker; 7 years' experience as foreman; best of reference. BOX 45, AMERICAN MACHINIST.

Wanted—A bright, energetic and reliable man to sell belting in New York and vicinity. "Manufacturer," care G. T. Moore, 91 Liberty St., City.

Wanted—Position by a draftsman, experienced in coal mining, rolling-mill, steel work and general machinery. BOX 44, AMERICAN MACHINIST.

Mech. draftsman (Swede), grad., with 6 years' exp. on engines and gen'l mach'y, wants position; best refs.; moderate terms. BOX 46, AM. MACH.

(*Continued on page 14.*)

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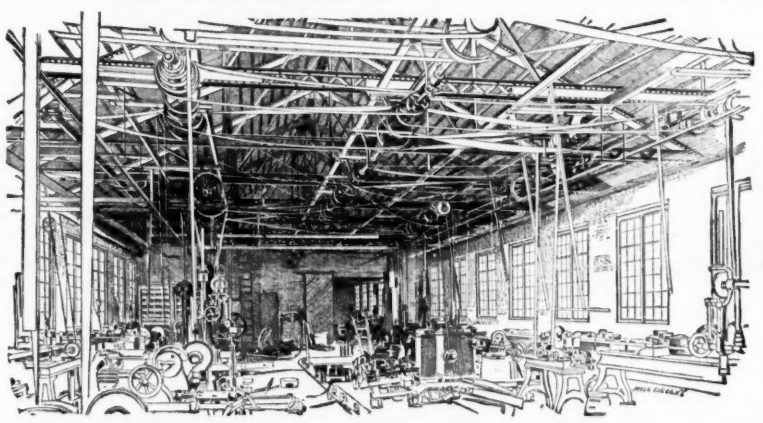

Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for The C. W. Hunt Co., at West New Brighton, Staten Island, New York. The building is 42 feet in width by 202 feet in length, and is used by the C.W. Hunt Co. as a Machine Shop. The side walls are of brick and the roof trusses of iron, with iron purlins covered with slate, so that no wood work is used about the construction of the building in any way, shape or manner, thus eliminating entirely the danger from fire. This is one of the best designed and equipped Machine Shops of its size in the United States.

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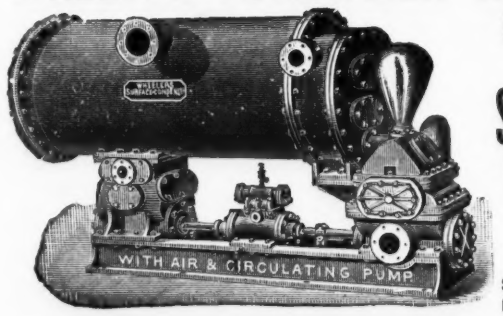

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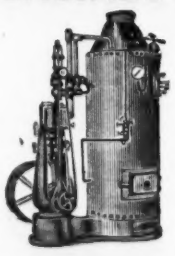

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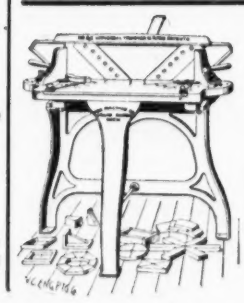

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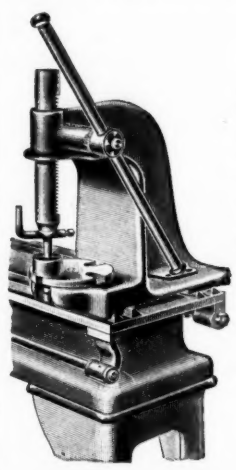

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12	2	1.20
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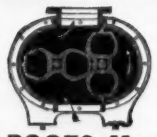

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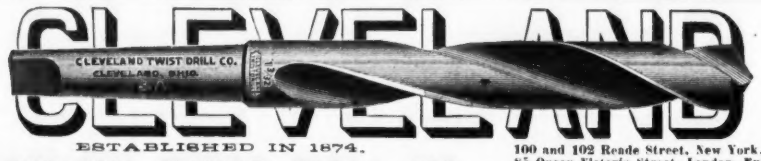

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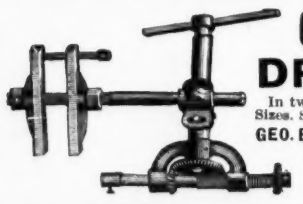

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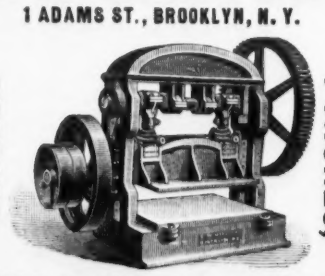

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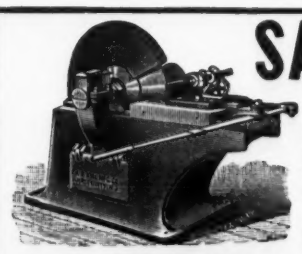

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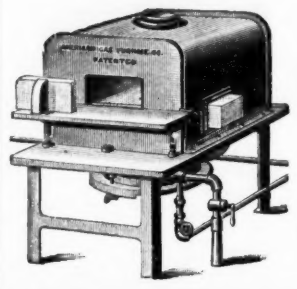

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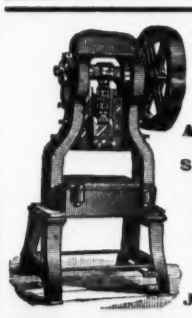

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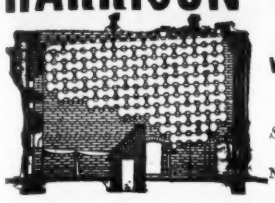

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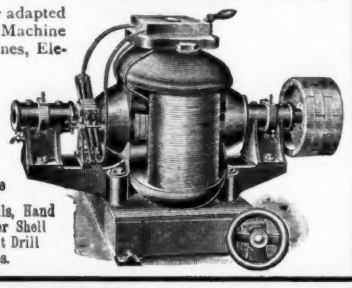

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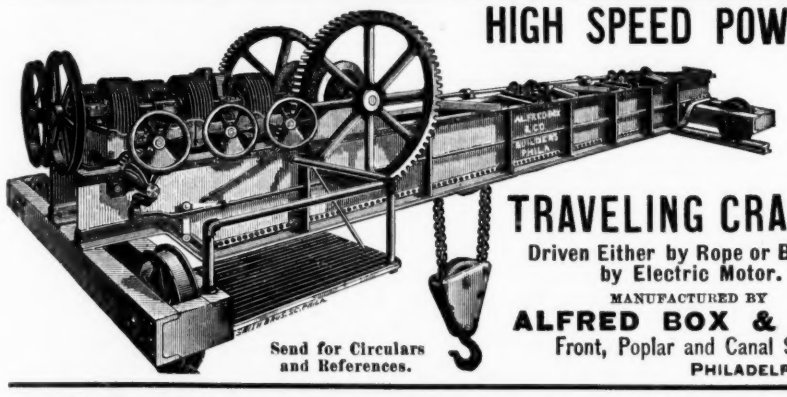

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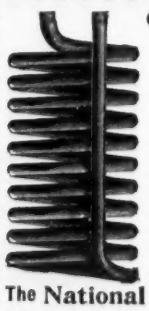

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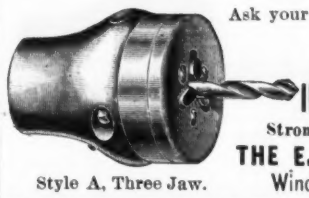

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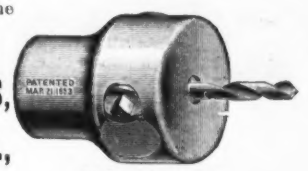

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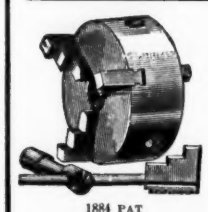
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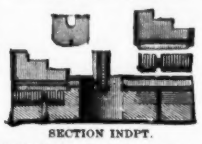
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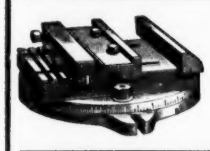

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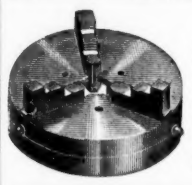

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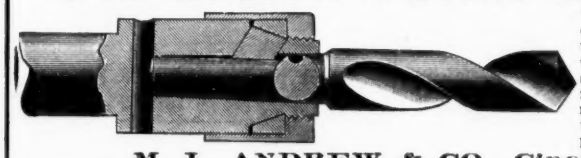

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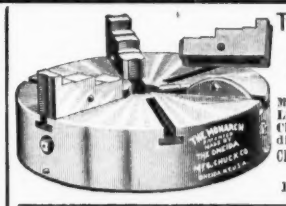

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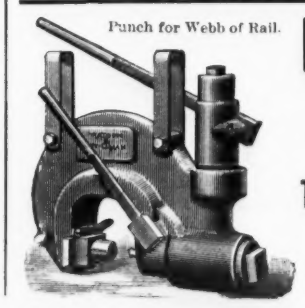

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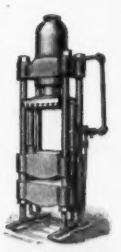
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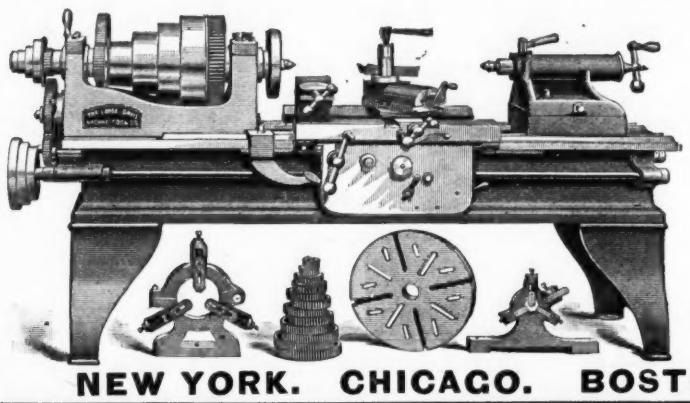

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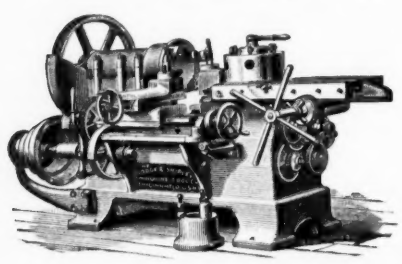

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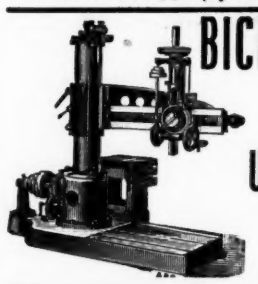

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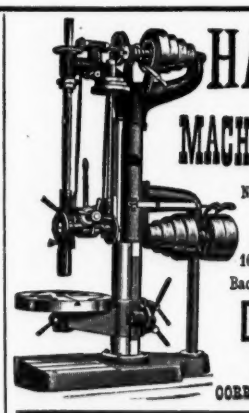

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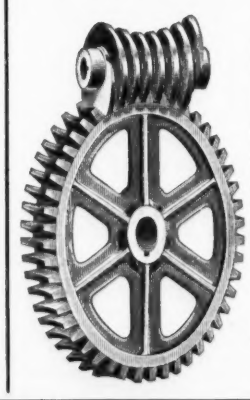

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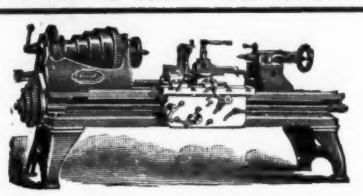

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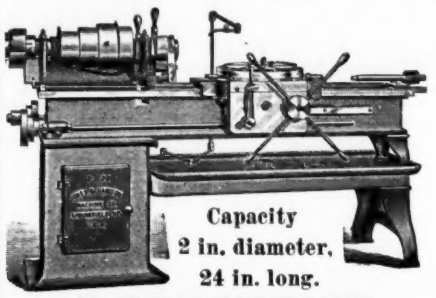

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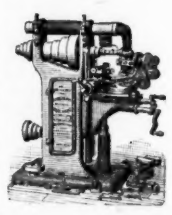

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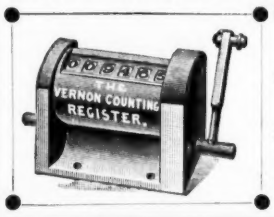

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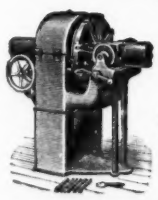

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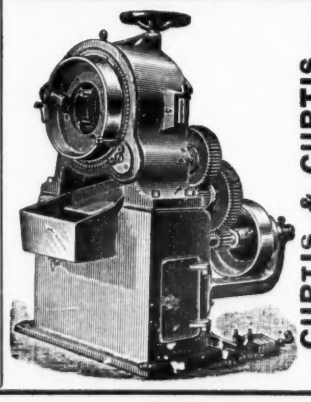

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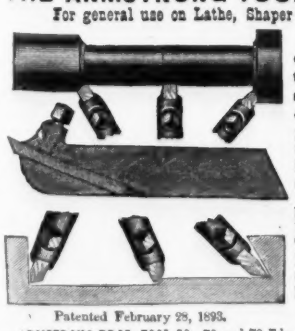

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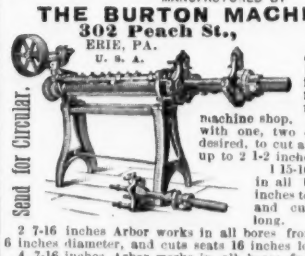

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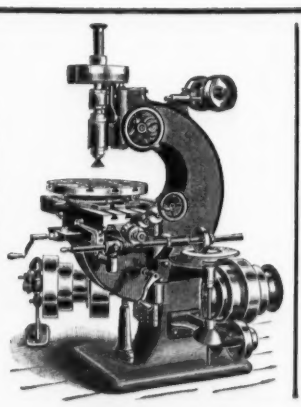

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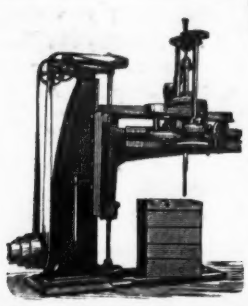

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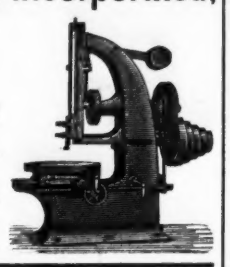

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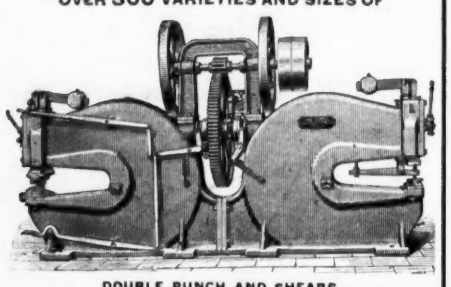

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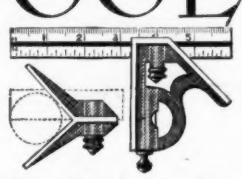

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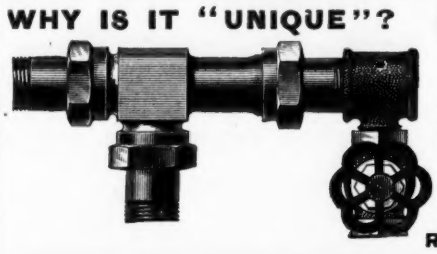

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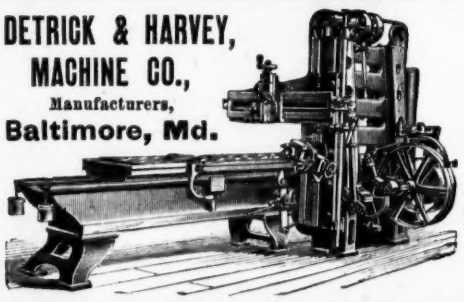

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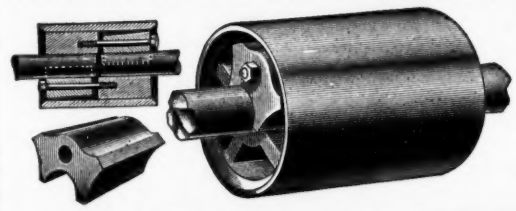

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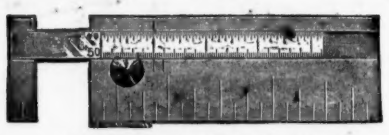

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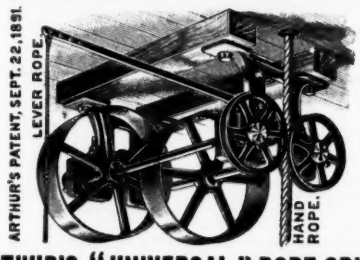

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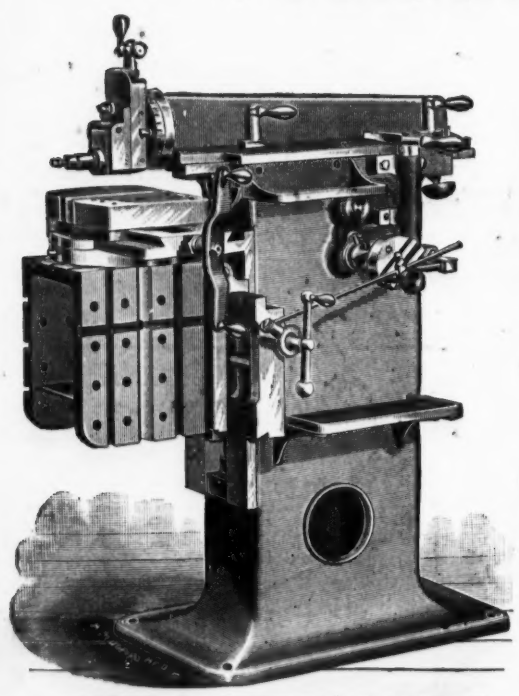

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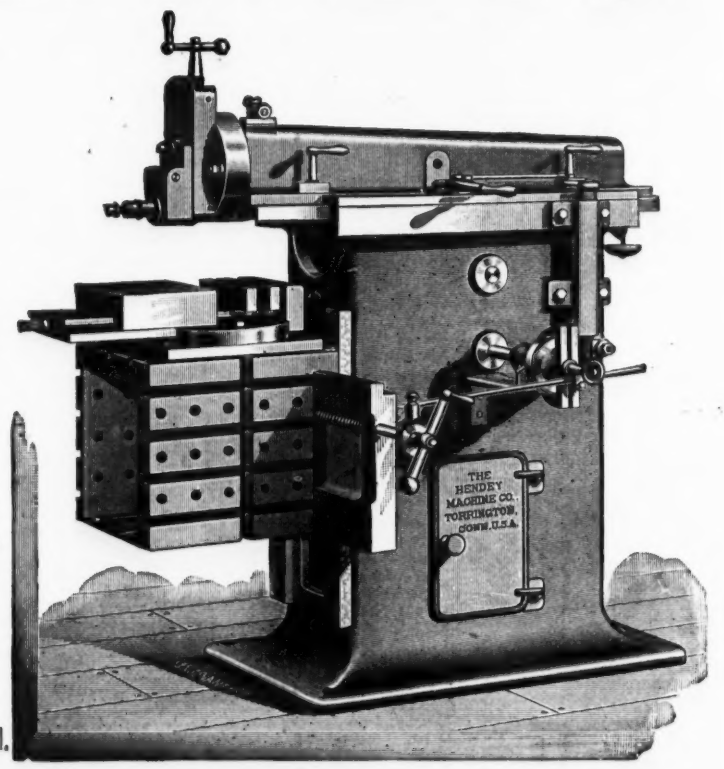

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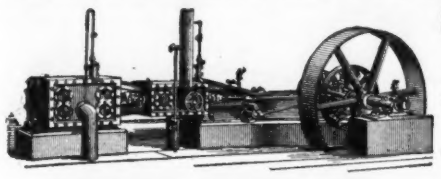

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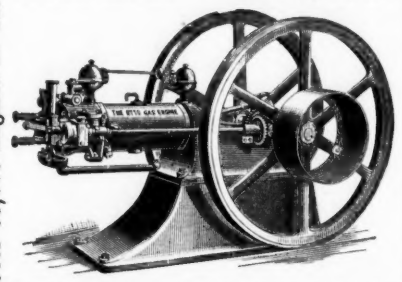

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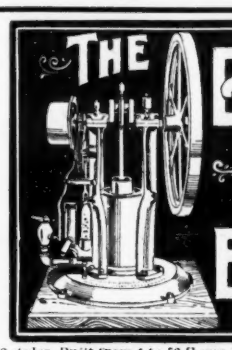

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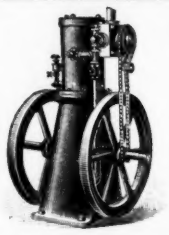

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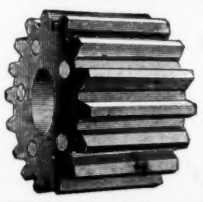

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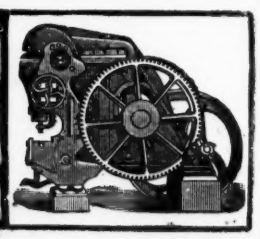

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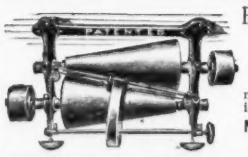

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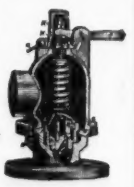

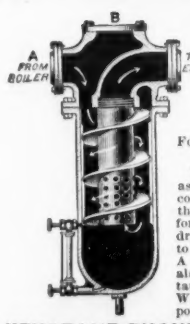

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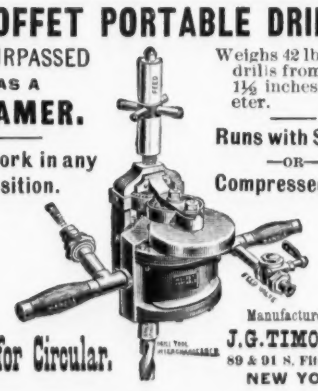

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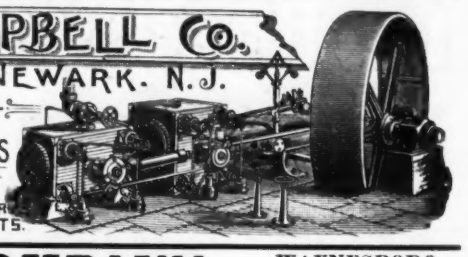

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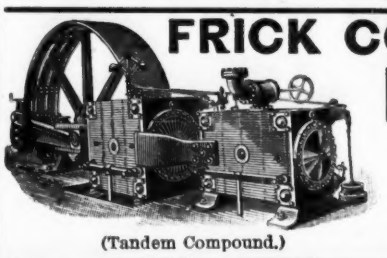

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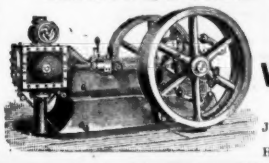

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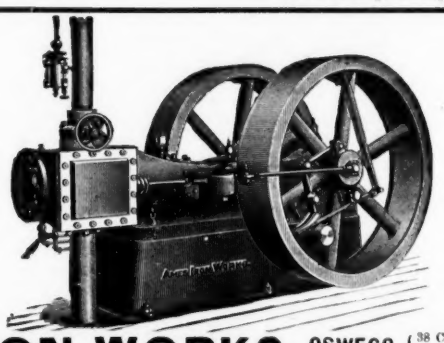

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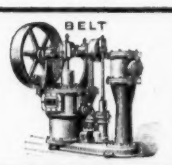

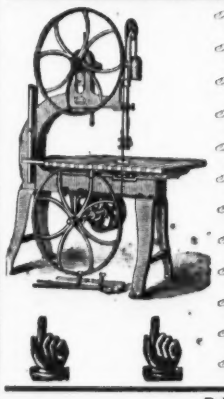

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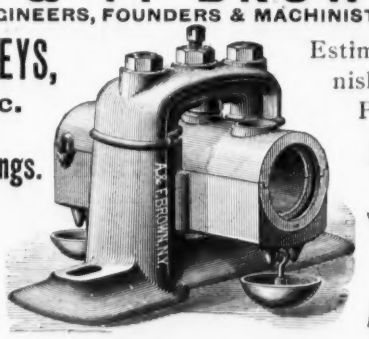

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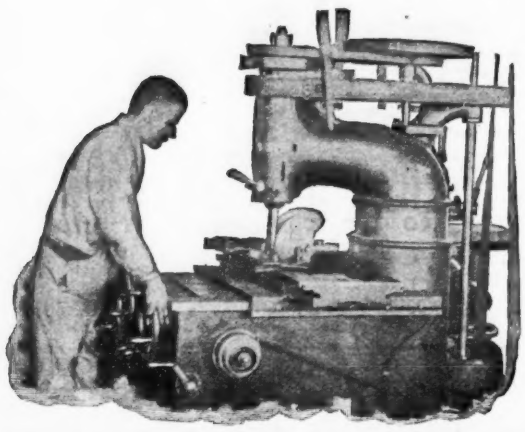

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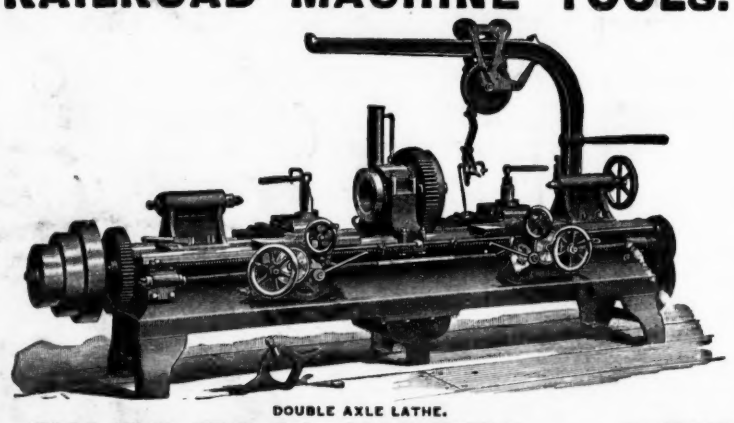

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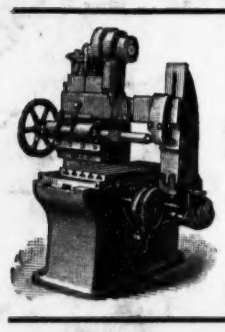

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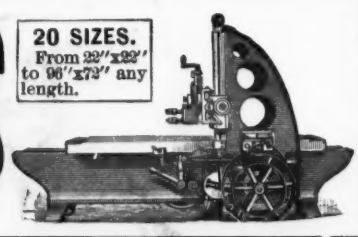

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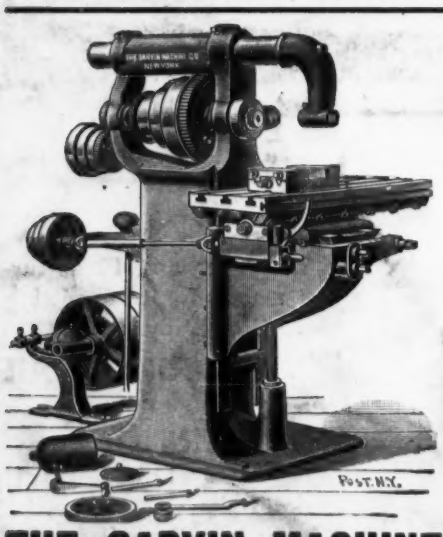

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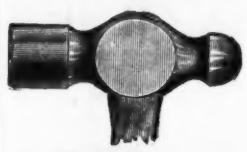

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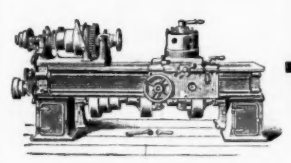

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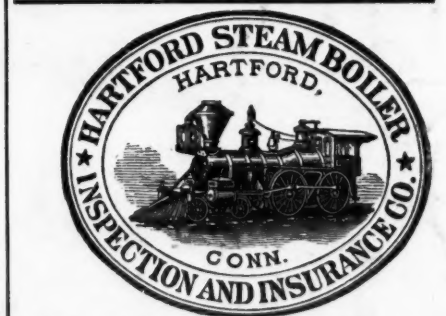

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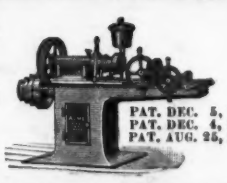

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